Academic Outreach

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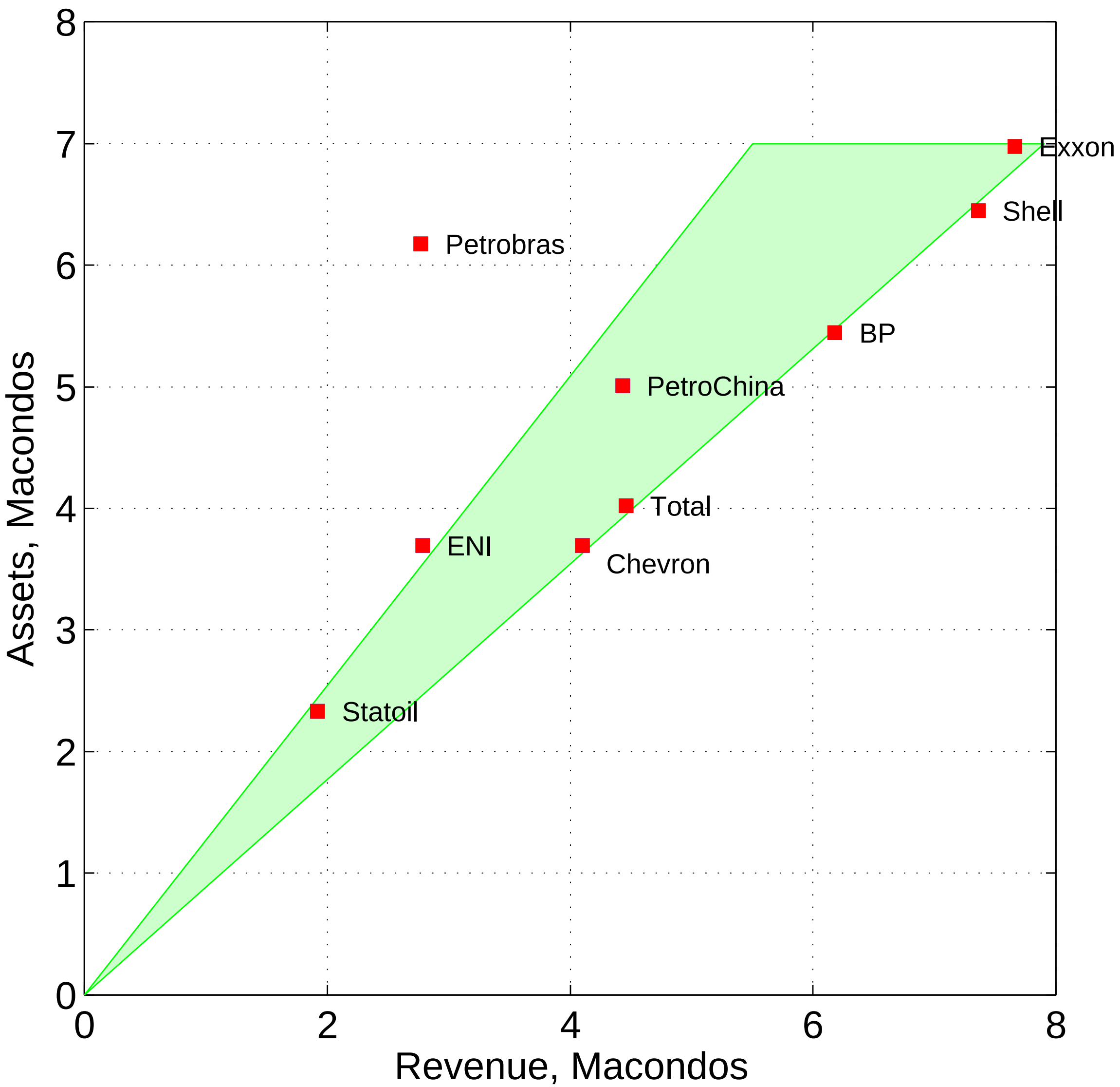
OESC Meeting, DOI, 1849 C Street, Washington D.C., Nov 7, 2011, 1:45 p.m.

Talk Outline

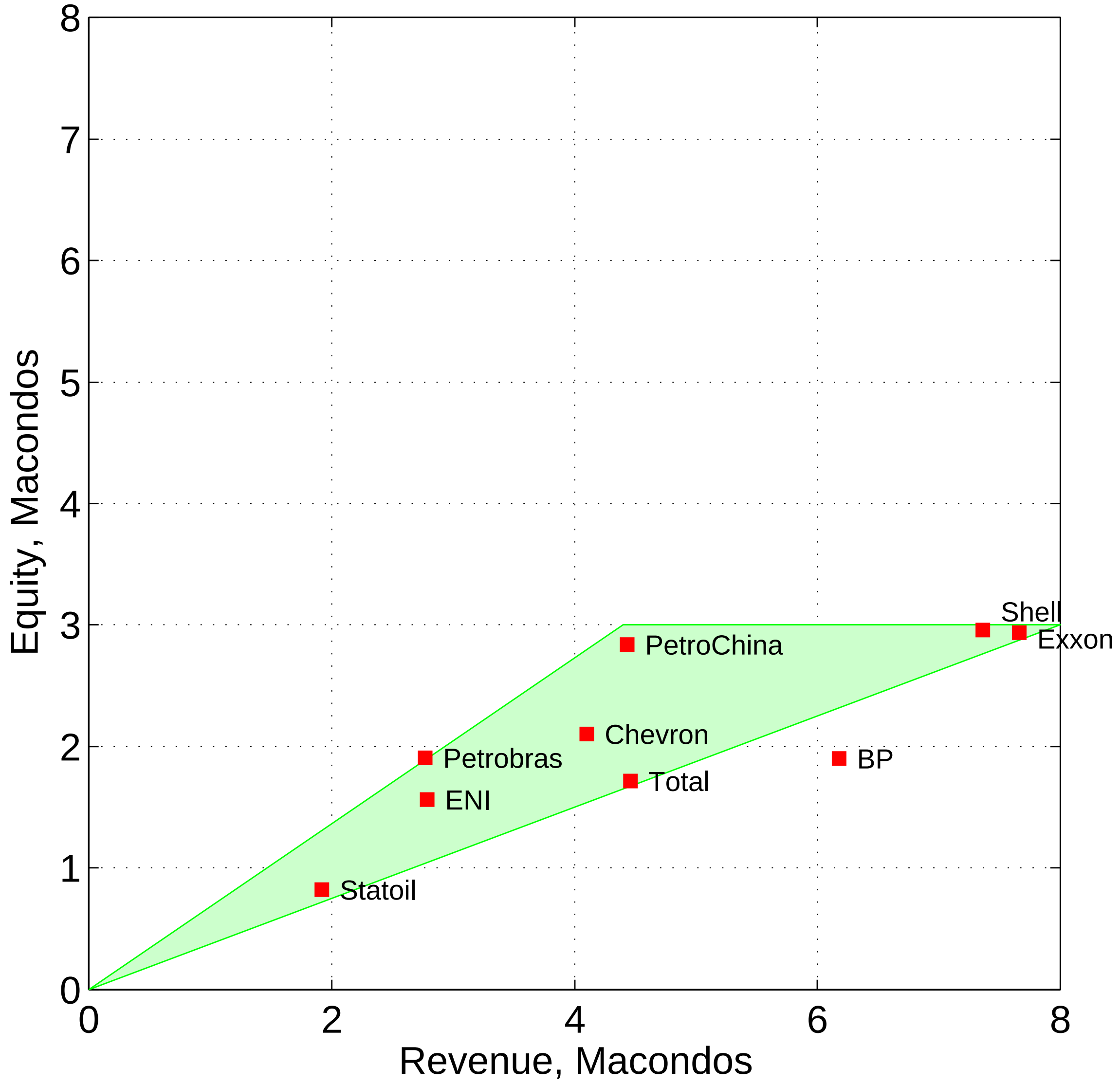
- Summary of facts and conclusions
- Possibilities of meaningful academic research in offshore safety
- State of science and engineering labor force U.S.
- State of engineering labor force, petroleum engineering in particular
- Principles of successful research
- Government and industry funding of research

Why Are We Here?



The measurement unit: 1 Macondo Accident = $50 billion

Why Are We Here?



Conclusion: It is difficult for anyone to survive a Macondo-like accident

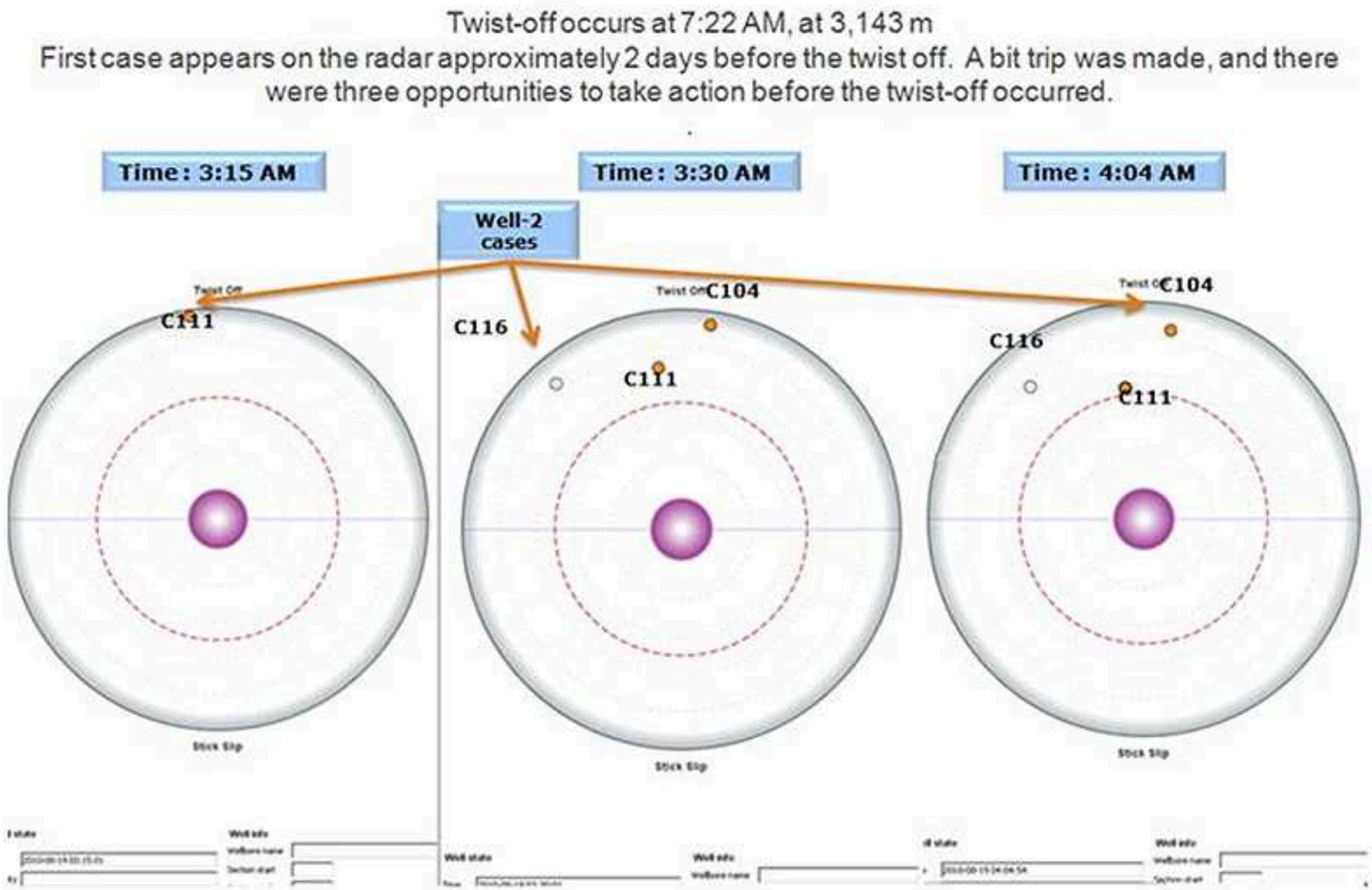
Summary of Relevant Facts

- The O&G industry and regulators in the U.S. have critical unfulfilled needs for qualified personnel
- Thus, inexperienced and nontechnical people are hired into drilling and other operations both on- and offshore
- The main danger to offshore safety is lack of experienced, coherent teams that work together for a long time
- The safety culture and procedures important, but high team turn over makes it fragile
- With increasing emphasis on remote control and supervision operations, there is even more dire need for experienced (10+ years) specialists in drilling, geosteering, mud logging, MWD, and LWD

Summary of Relevant Facts

- Given more resources, Academia in the U.S. could provide more educated and trained O&G workers
- Given more funding, Academia could develop new education technologies to provide hands-on learning-by-trying for students
- Given more research funding, Academia could develop more sophisticated physics-based models of major steps in offshore operations, and pattern recognition software to detect possible/ impending failures
- In summary, a healthy Academia could be a force vital to the industry and regulators

Pattern Recognition



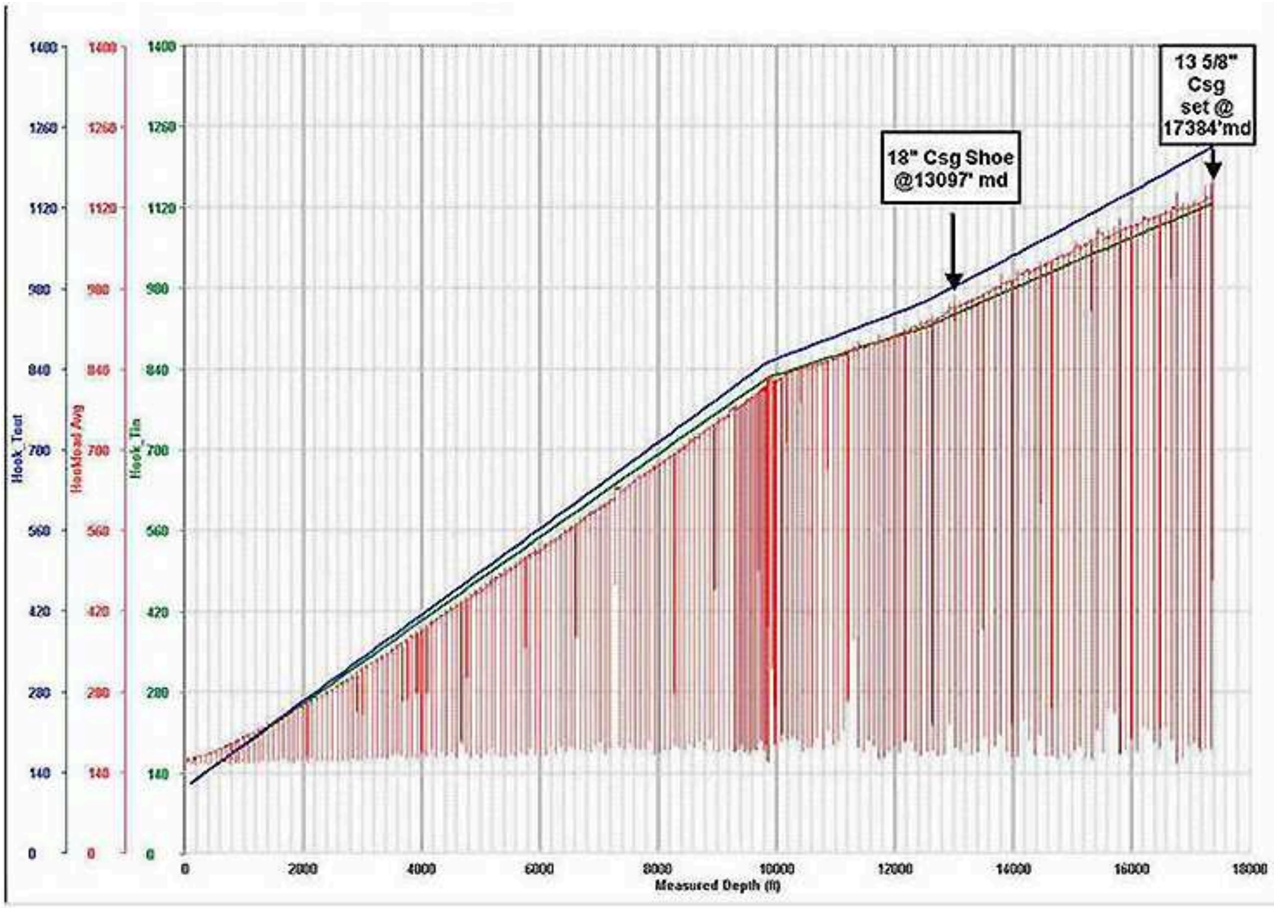
Physics of failures is the same across the world; surface sensor data have existed for 10 years

UG/grad PE courses can be designed to evaluate, analyze, and create a catalog of well failures

Sophisticated pattern recognition algorithms can be devised to catch impending failures

Image source: Prof. Eric van Oort, UT Austin

Process-based models



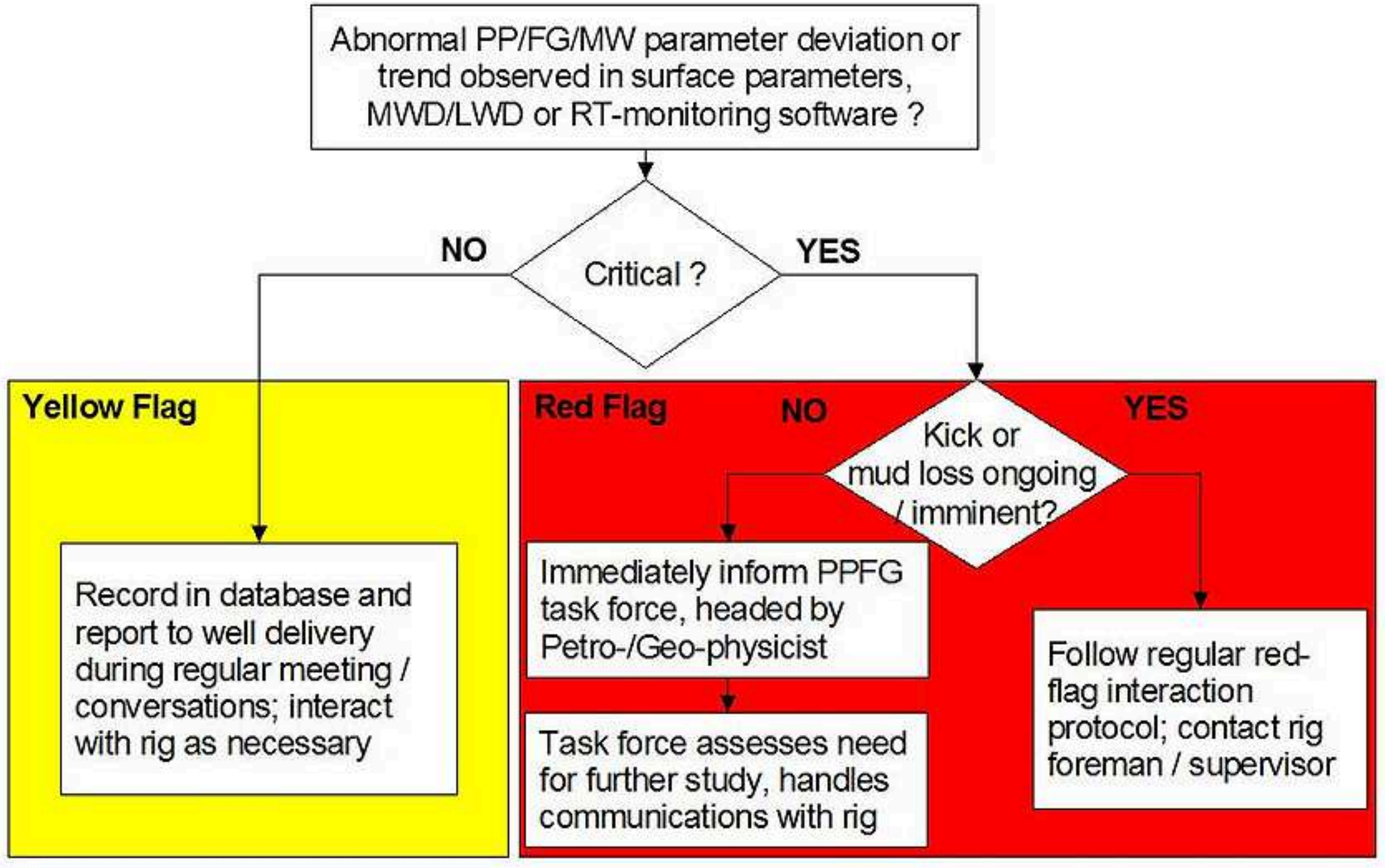
One can model all steps in well design and compare the model with actual performance

Large deviations from the model are flagged to operator and remote real-time operations center

Model behavior and statistics of deviations can be a subject of academic research

Image source: Prof. Eric van Oort, UT Austin

Decision making



PP = pore pressure, FG = fracture gradient, MW = mud weight

Sensor data and model comparisons can be fed into a decision-making platform

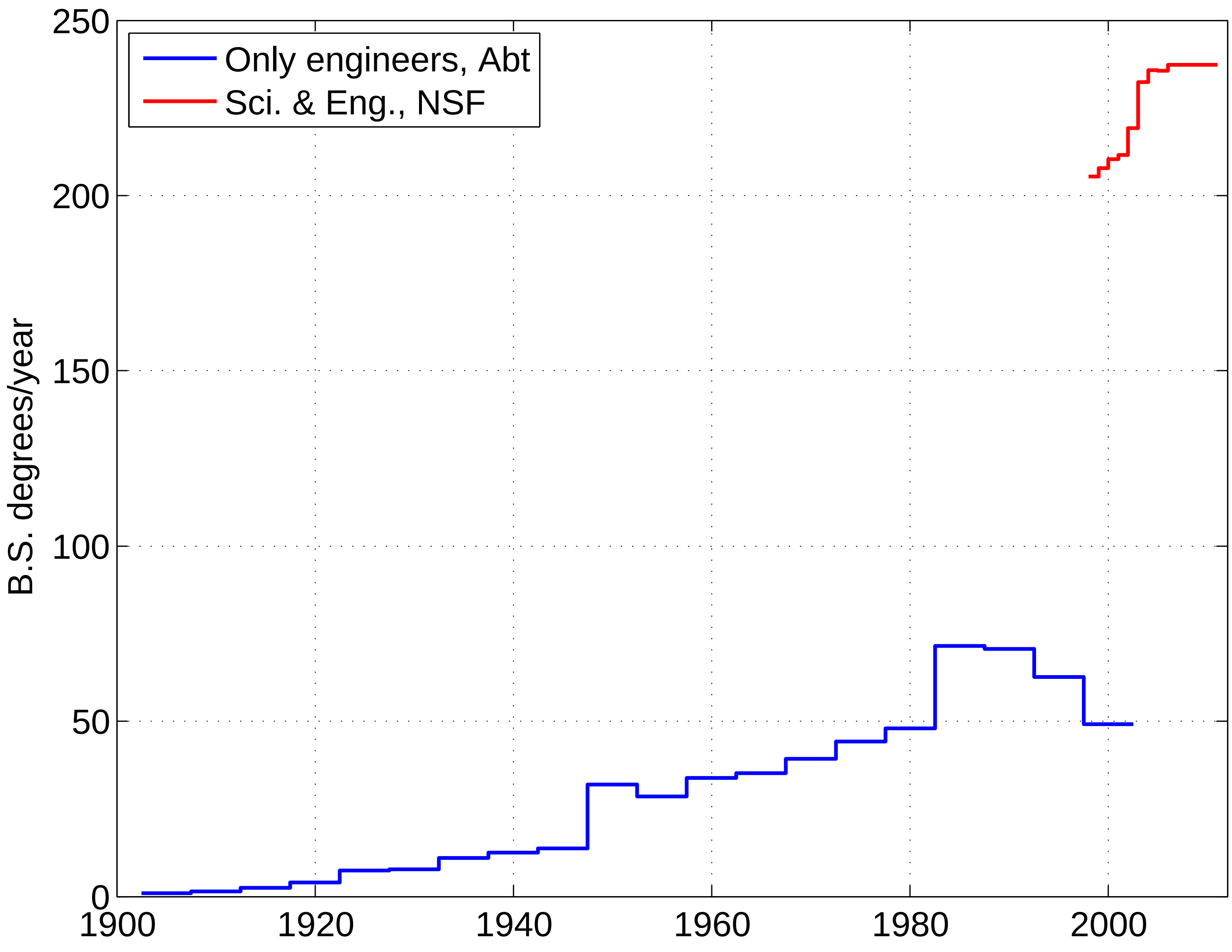
Features and performance of this platform can be a subject of academic research

Image source: Prof. Eric van Oort, UT Austin

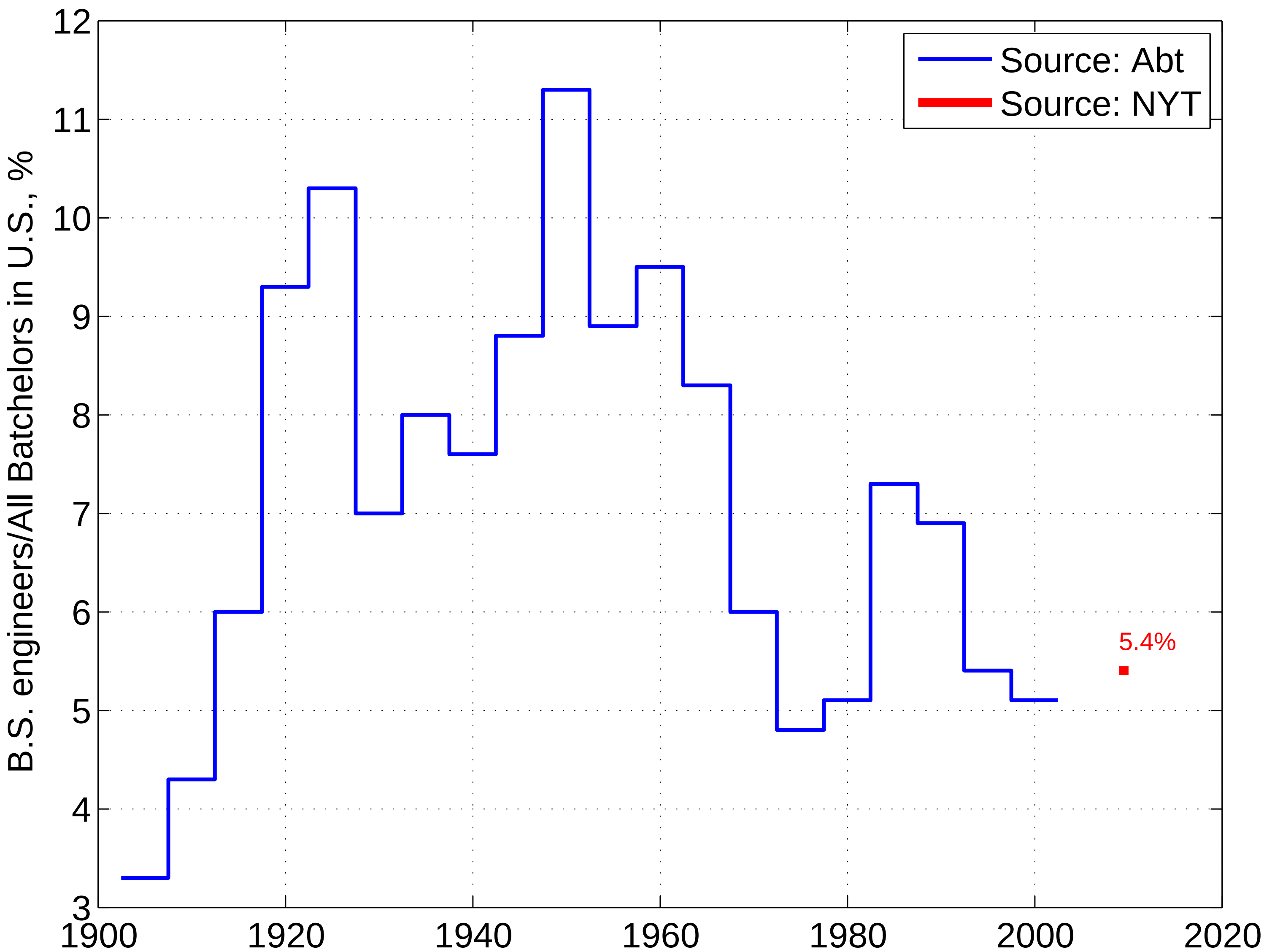
U.S. Eng. & Sci. Statistics

- There are 3.6 million native workers and 1.2 million foreign born
- The ratio of native/foreign-born workers declined from 6:1 to 3:1 over the last 15 years
- In 1999, there were 1.7 million practicing engineers; in 2008, this number decreased to 1.2 million
- Petroleum Engineering Departments enroll about 5,000 B.S., 1,000 M.S., and 500 Ph.D. engineers
- Current number of Petroleum Engineering (PE) Tenure-Track faculty, 193, is woefully inadequate
- U.S. PE Student/Faculty ratio is 34, UT's is 42

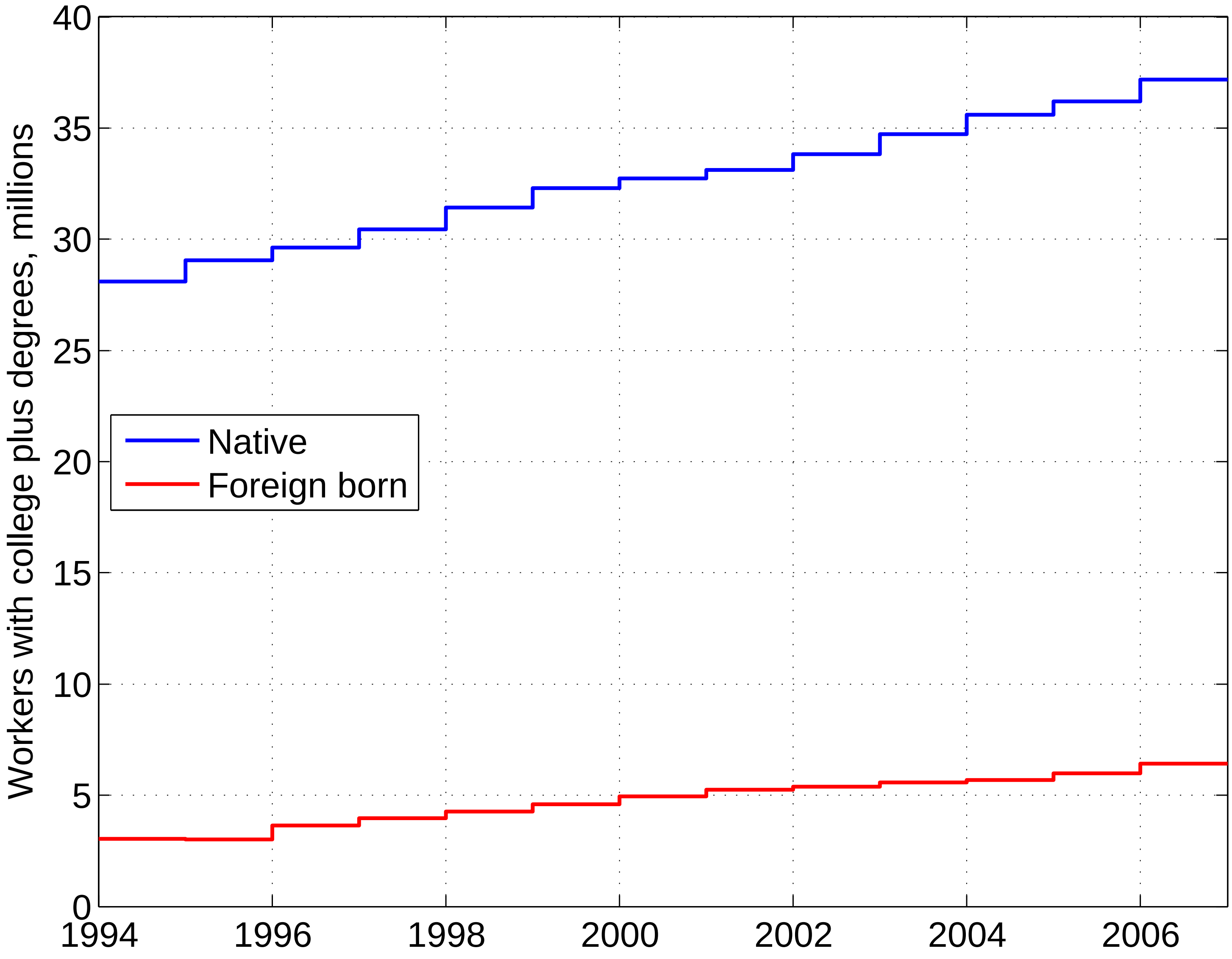
B. S. Degrees in Engineering in U.S.



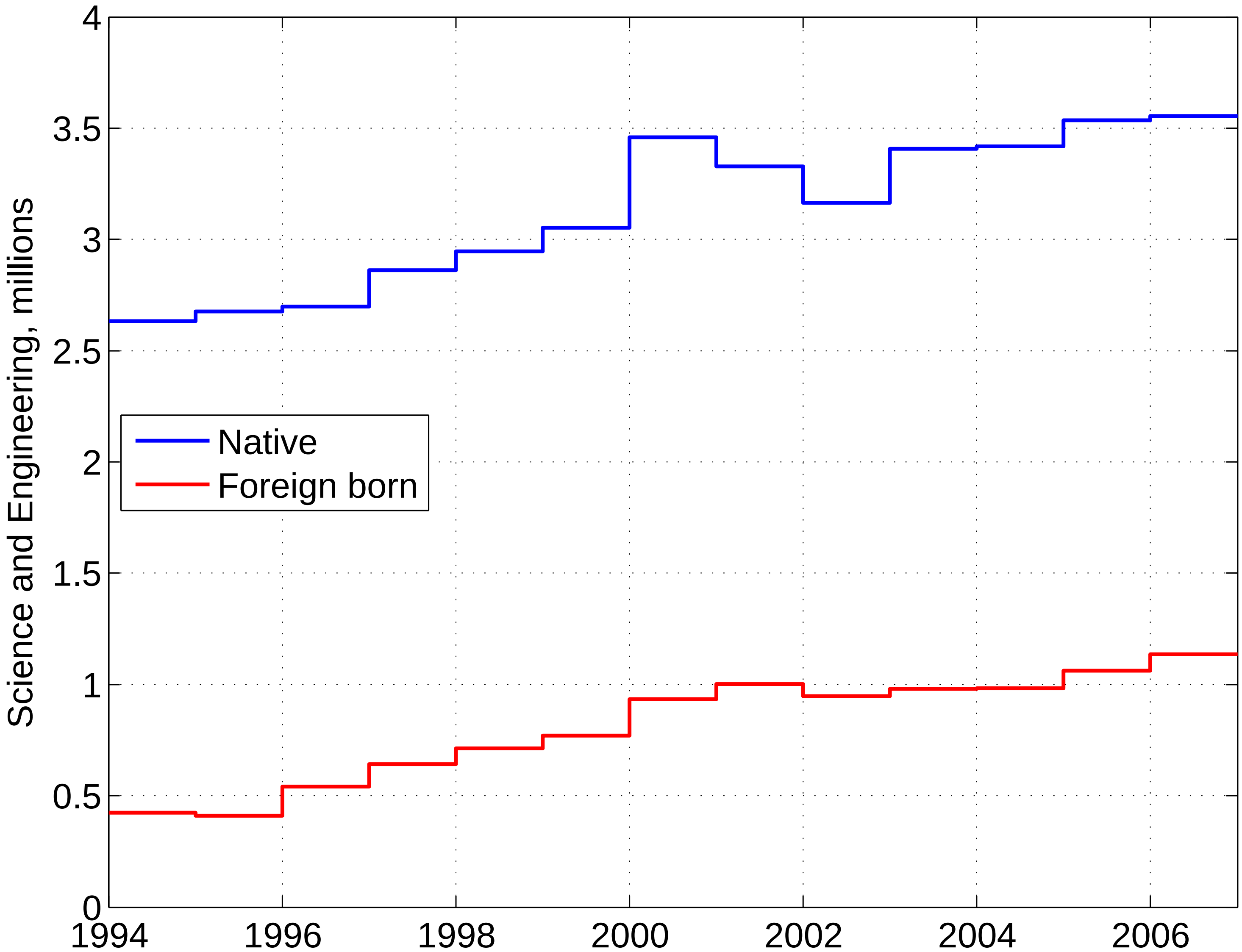
Fraction of B. S. Engineers in U.S.



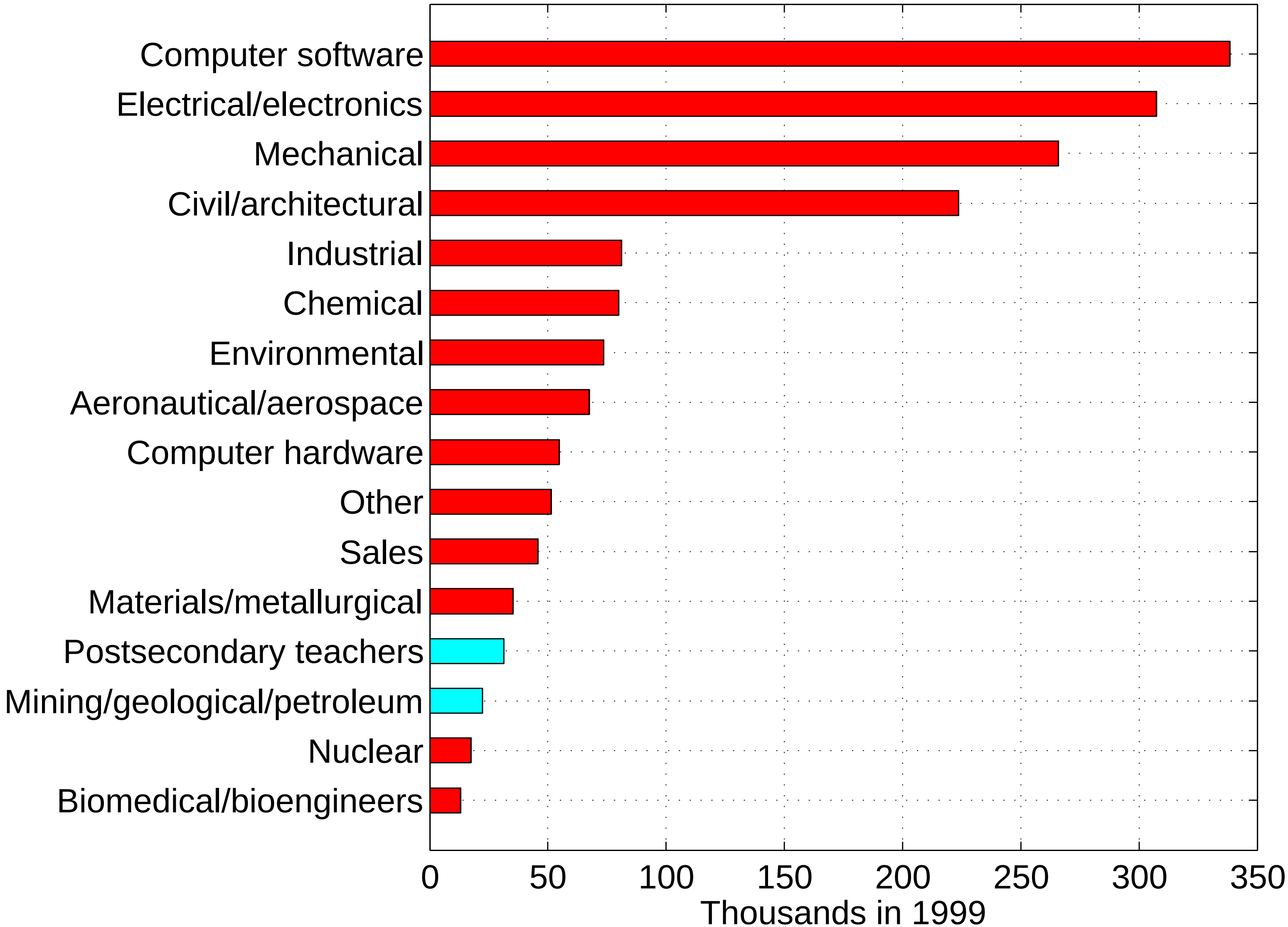
U.S. Postgraduate Labor Force



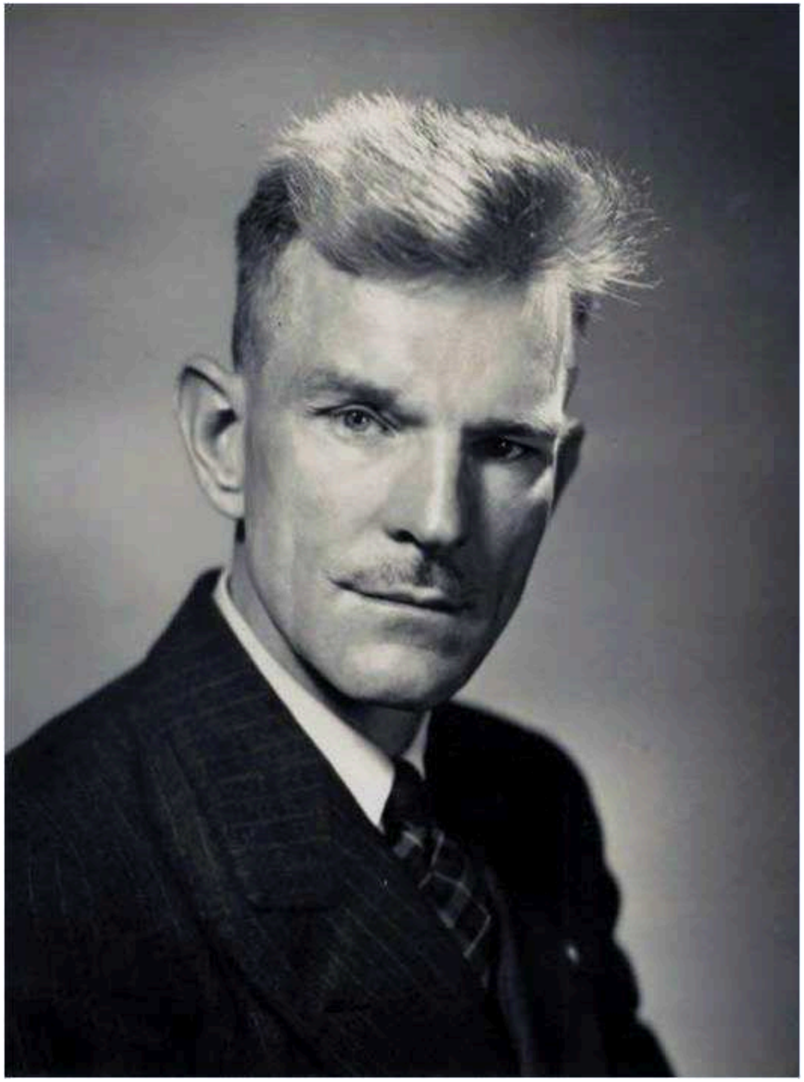
Science & Engineering Labor Force



Practicing Engineers in U.S.

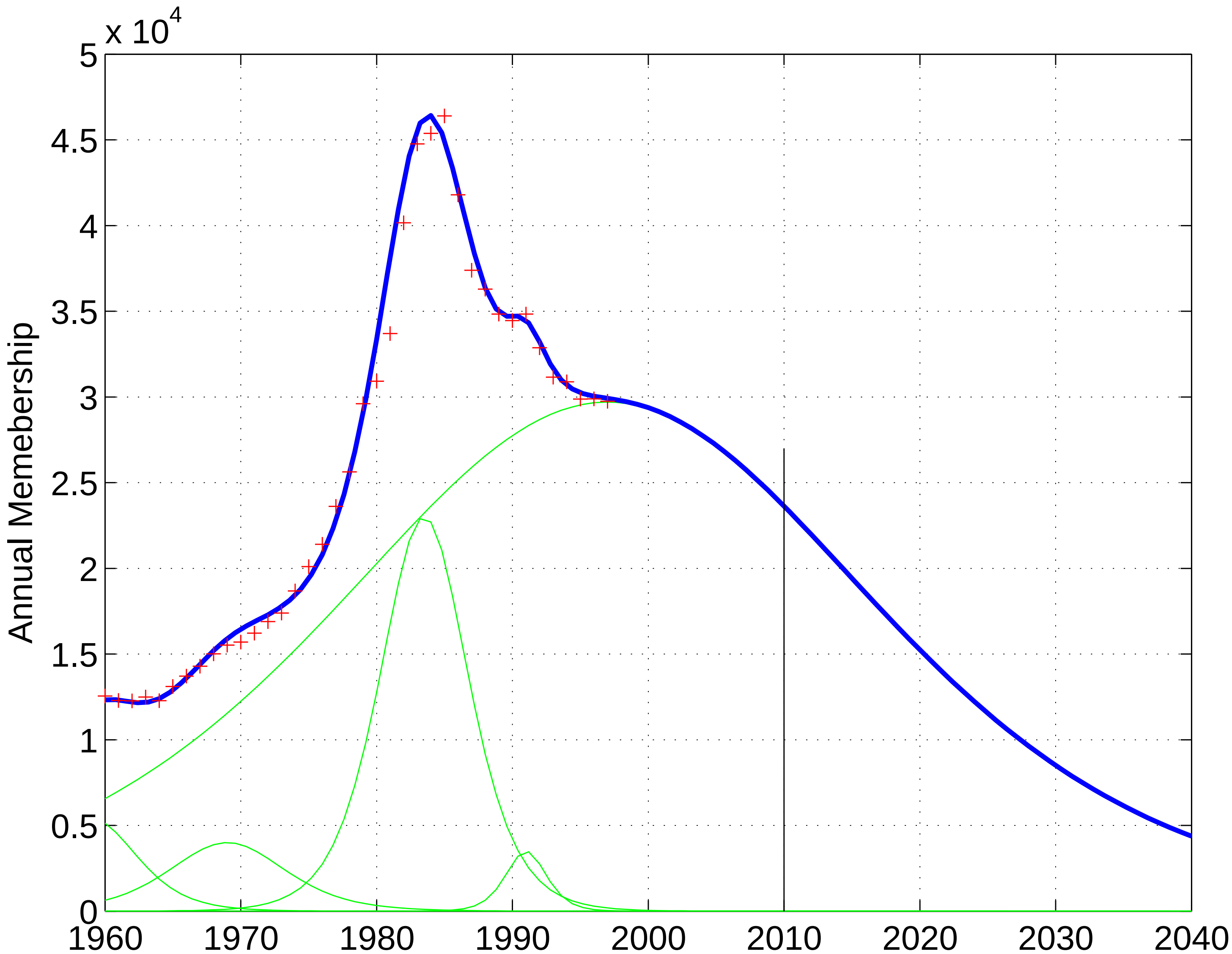


Marion King Hubbert

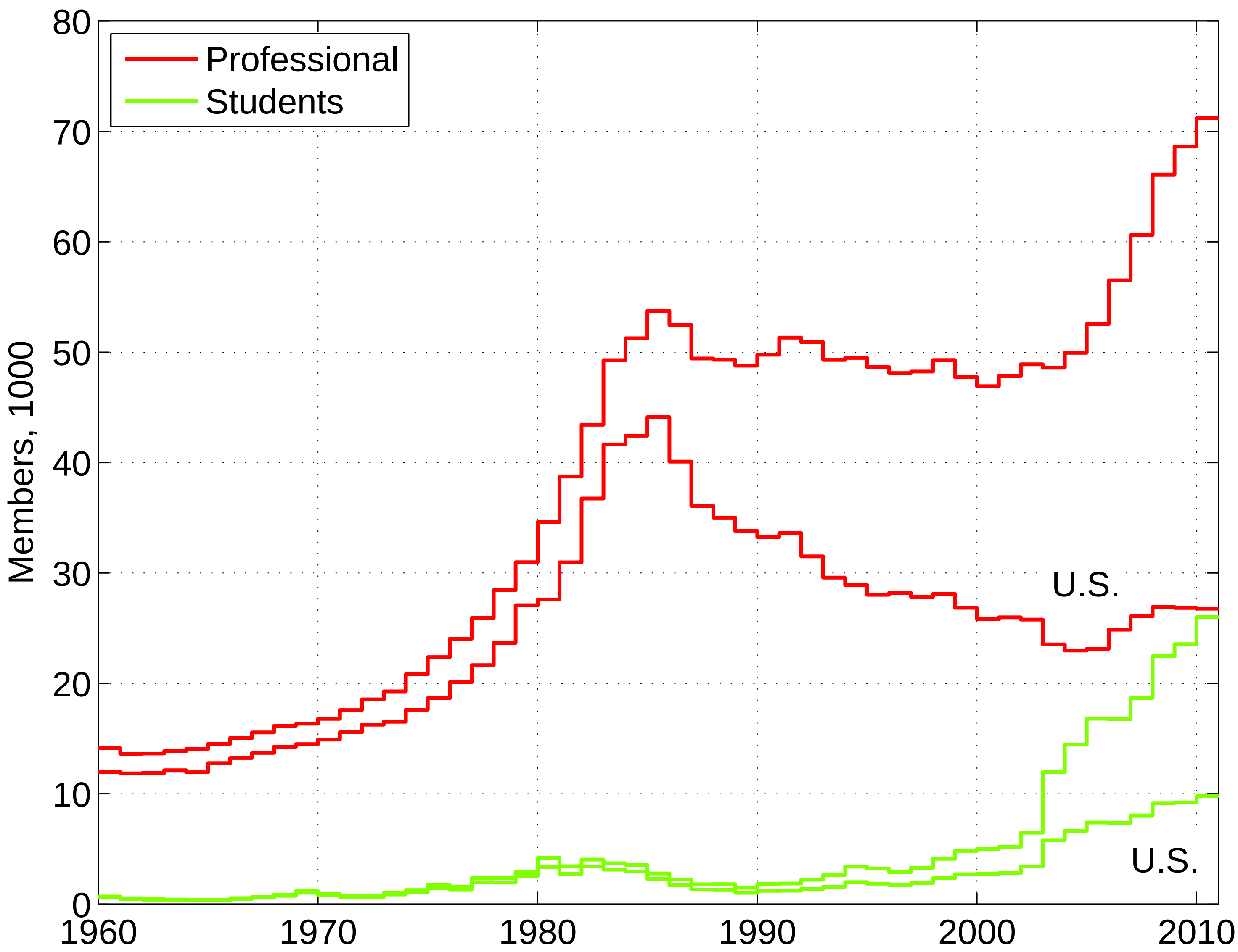


Born in San Saba, TX, 1903; died in 1989

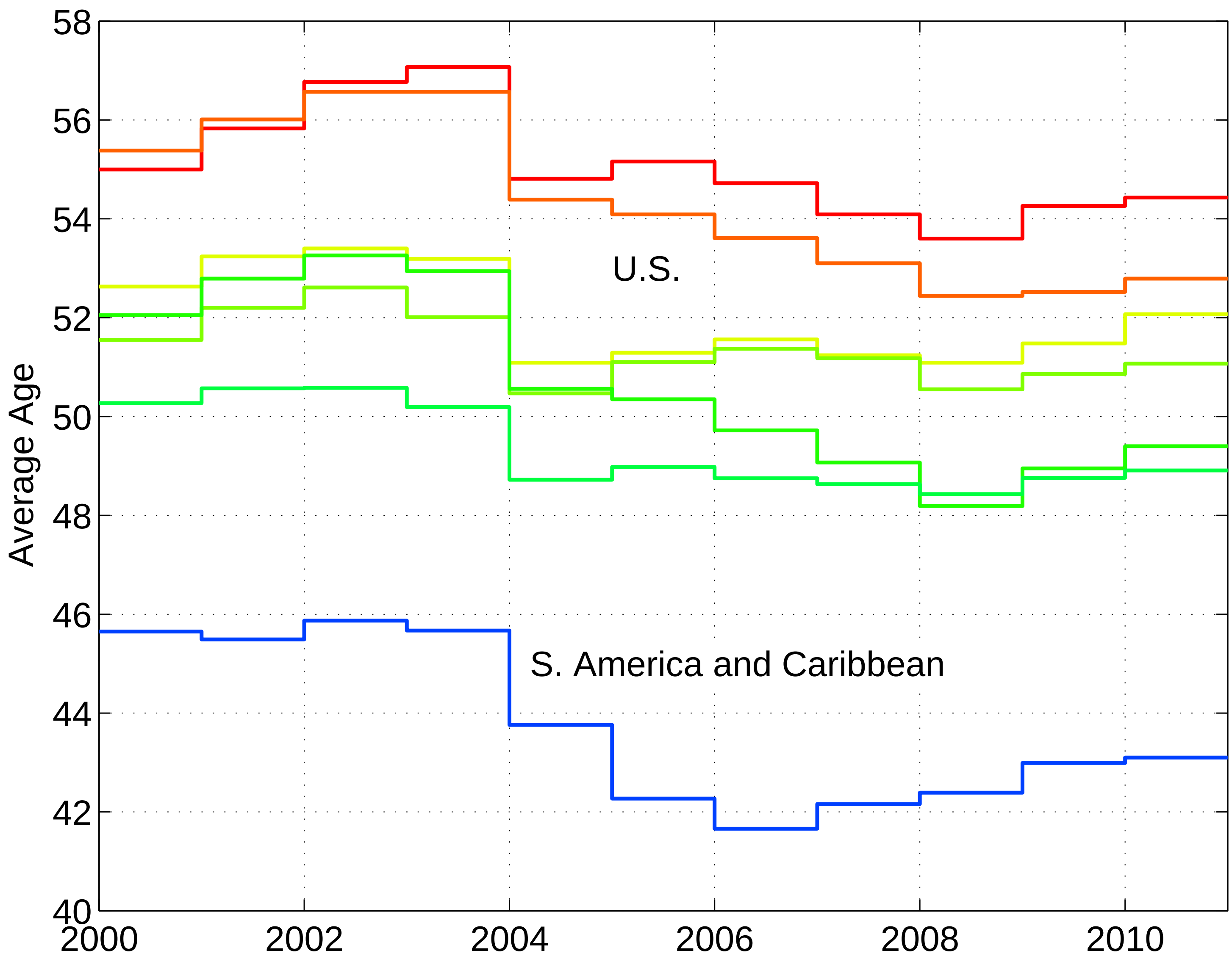
Professional Members of SPE in U.S.



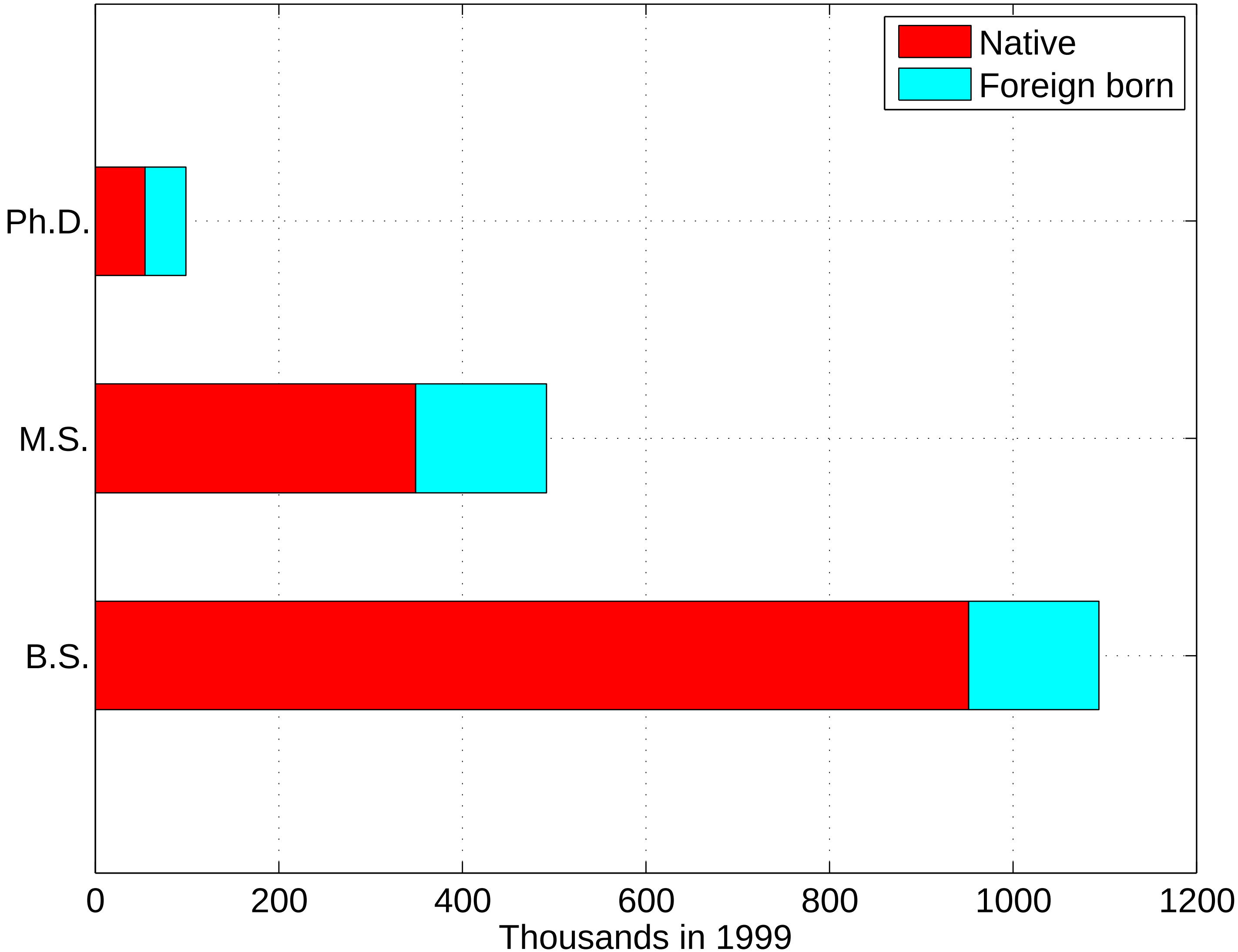
All SPE Members



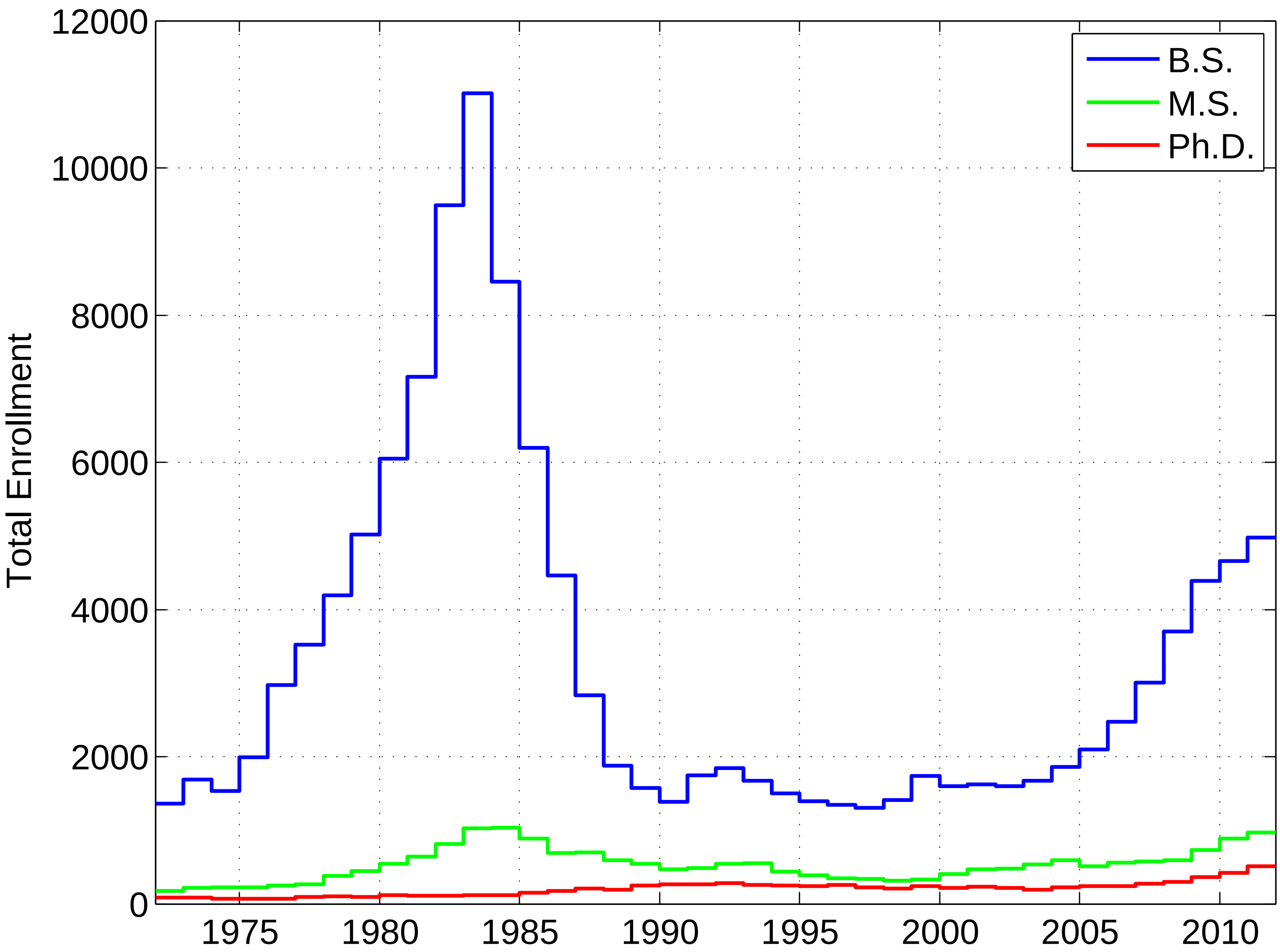
Ages of SPE Members



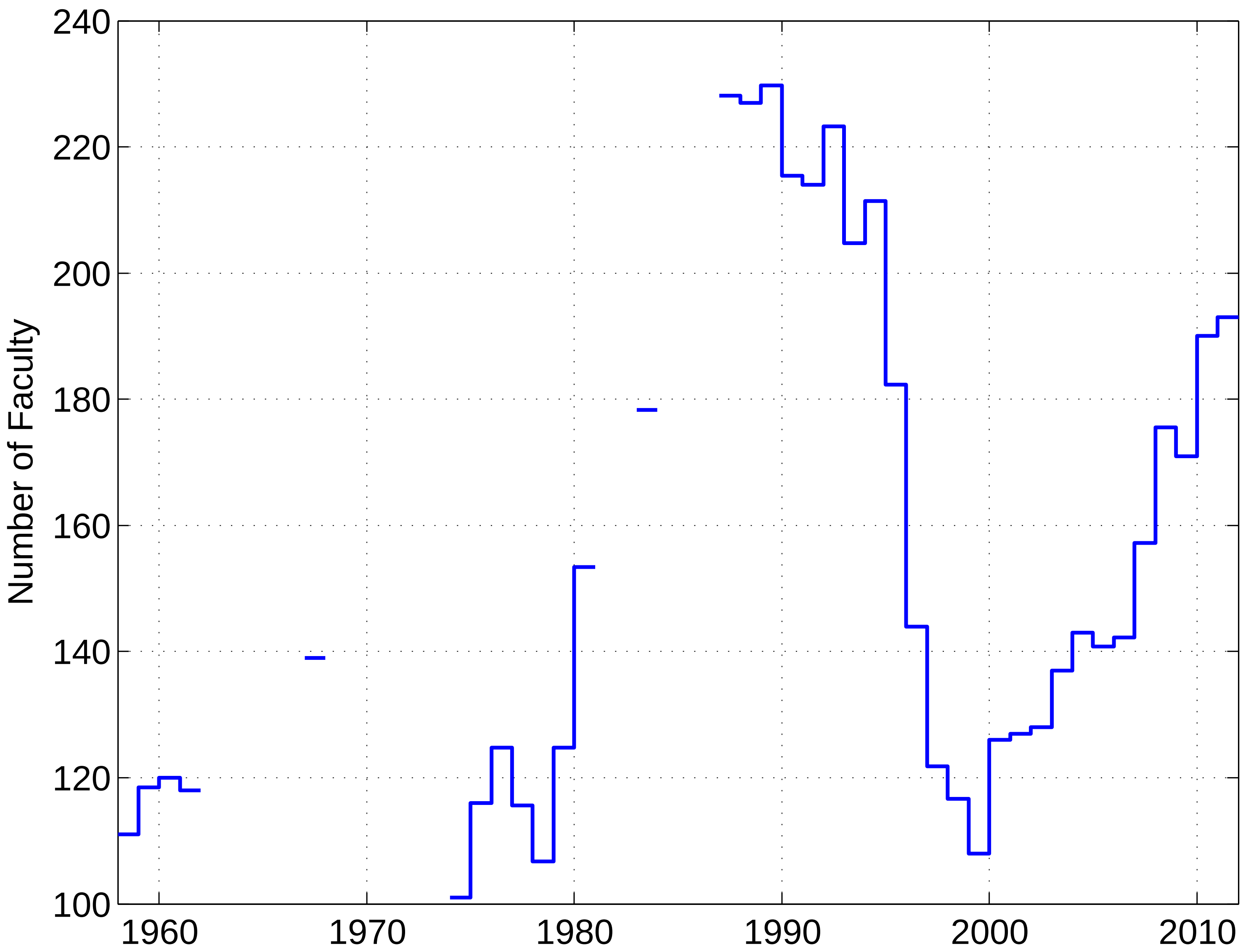
Engineers by Terminal Degree in U.S.



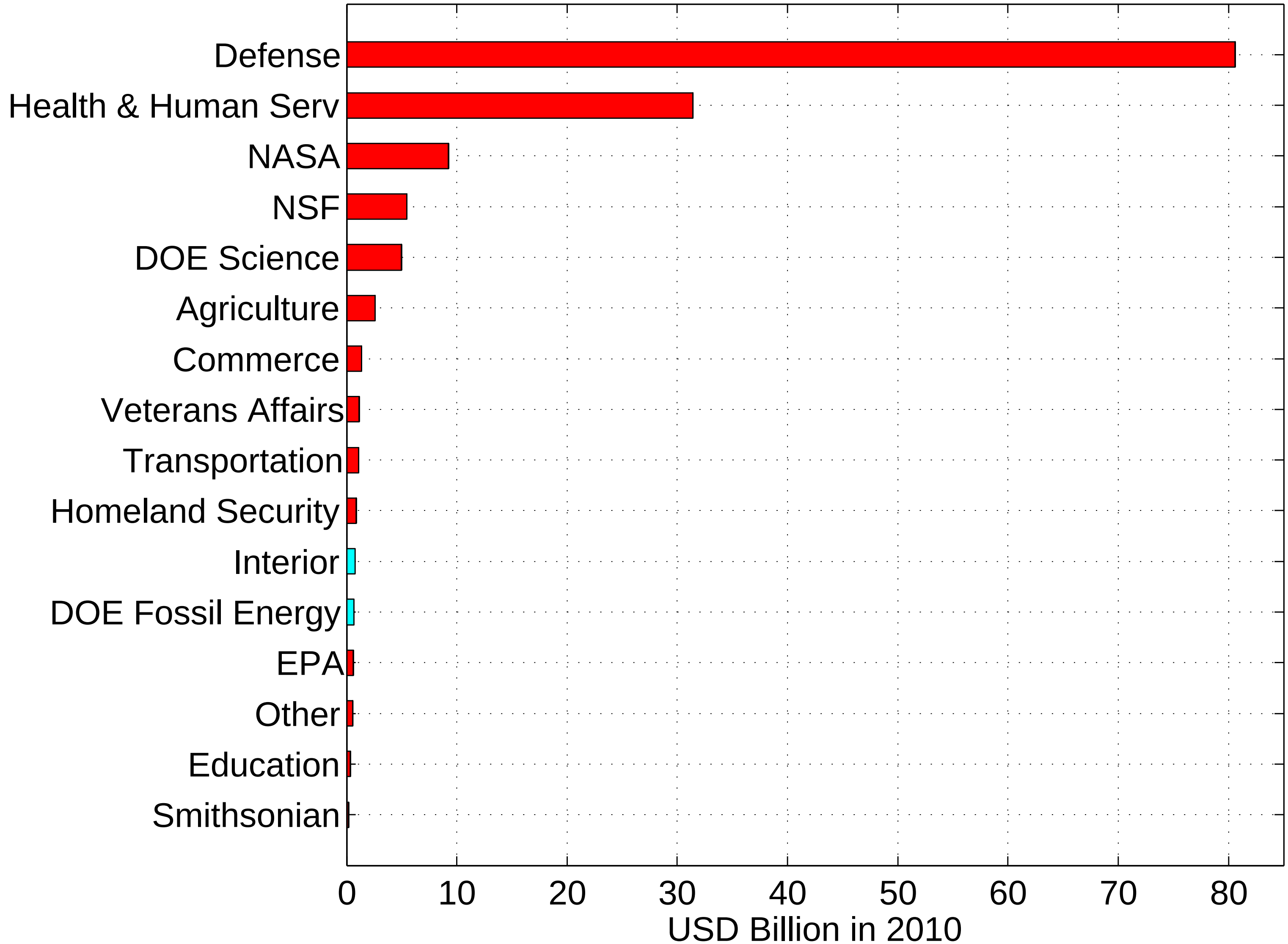
PE Enrollment in U.S.



Petroleum Faculty in U.S.

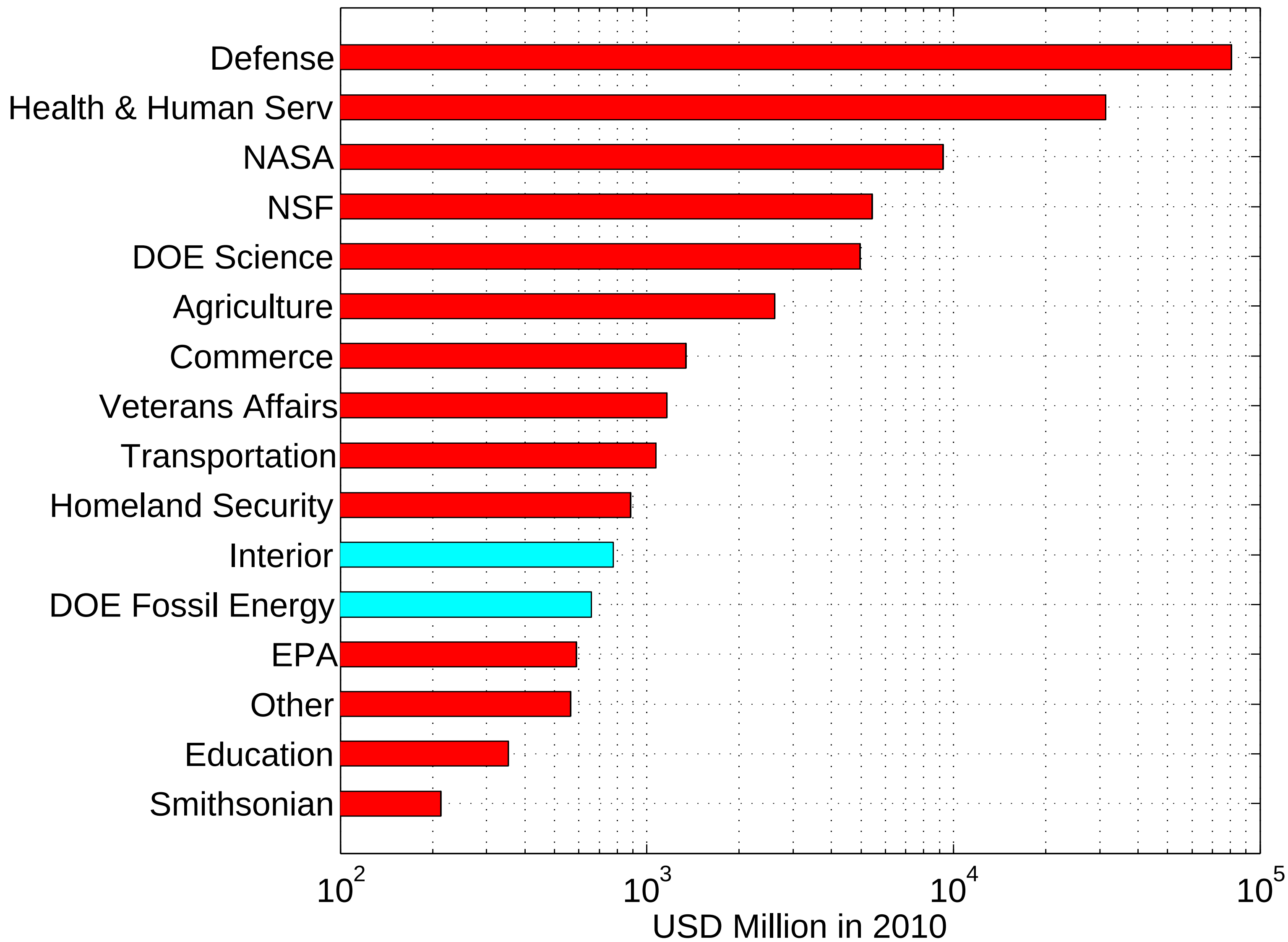


Federal R&D Spending in 2010



All government funding is spoken for

Federal R&D Spending in 2010



On the logarithmic scale, potential funding sources become visible

No Time Left. . .

Backup Slides

Industrial and Academic Research

- The holistic engineering by the industry must now be merged seamlessly with the integrative science by academia
- Because of complexity, the best science today is collaborative and fabulously expensive
- With few exceptions days of $50K/company JIPs are over

That the integrative science can be split into small tasks at the expense of rate is the only saving grace that prevents the limited industrial R&D from collapsing altogether when faced with new, much stricter demands

Science and Technology

- Without new types of data of ever higher resolution, acquired with devices of ever increasing power, modern science cannot function
- Technology provides the data gathering capability for science
- Science in return provides new theory and methods to design and construct the new sensors and machines
- At any given moment, progress of science can occur only within the barriers set by the available technology

Progress in Science

Planck's Principle:

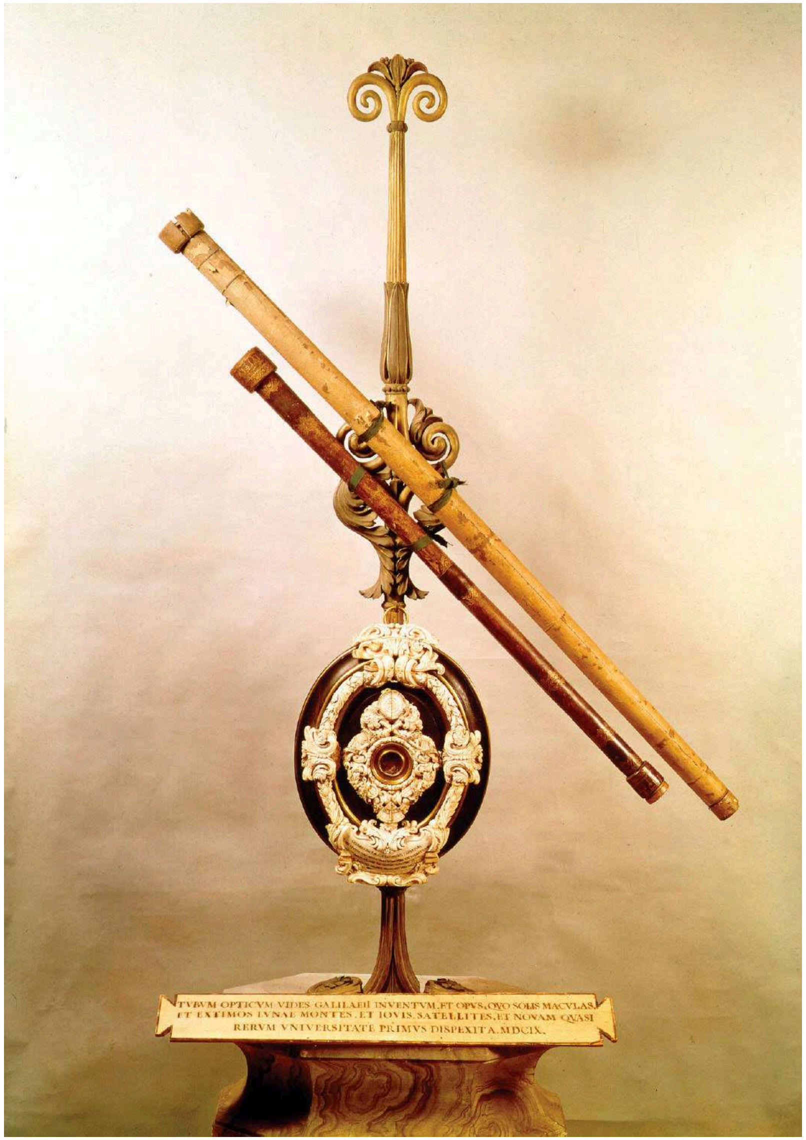
To be sure, with every advance in science the difficulty of the task is increased; ever larger demands are made on the achievements of researchers, and the need for a suitable division of labor becomes more pressing.

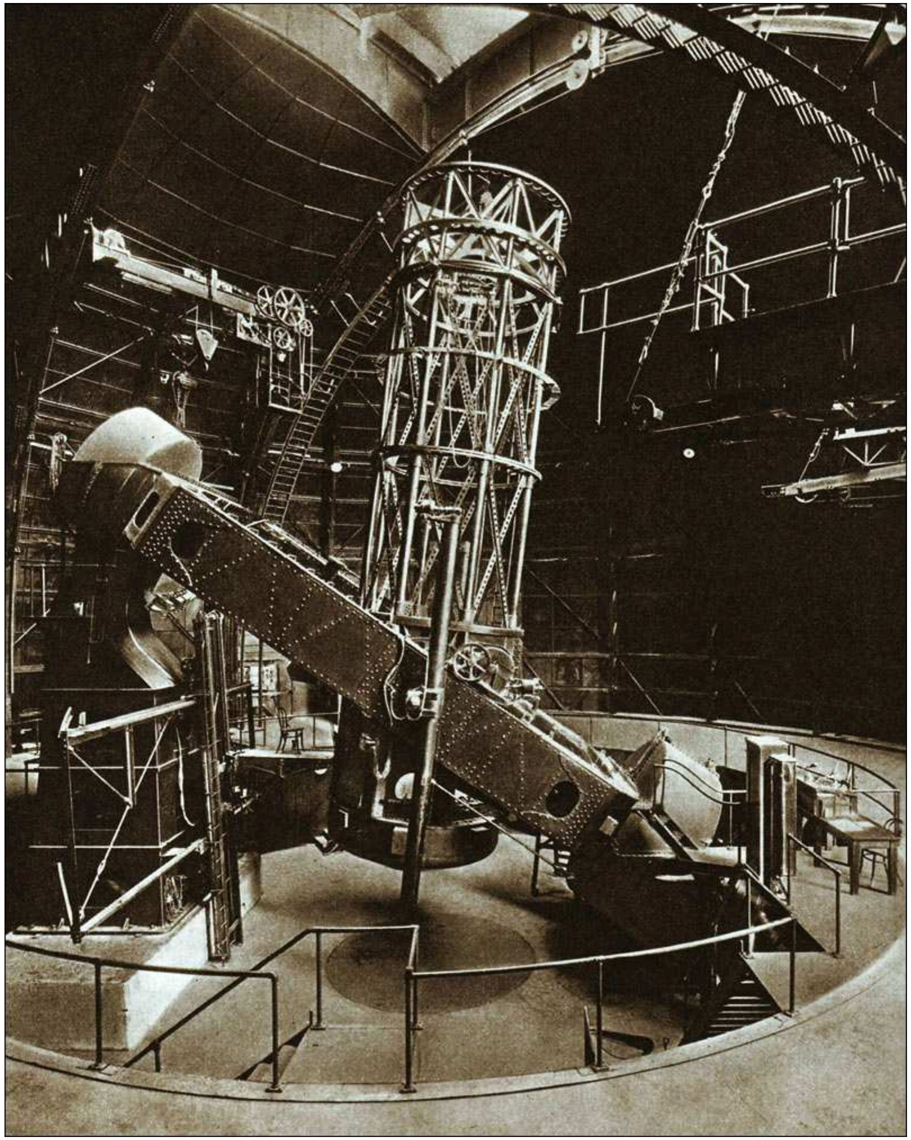
Vorträge und Erinnerungen (Lectures and Recollections),

5th Ed. Stuttgart, 1949.

Max Karl Ernst Ludwig Planck, 1858 - 1947

Science and Technology



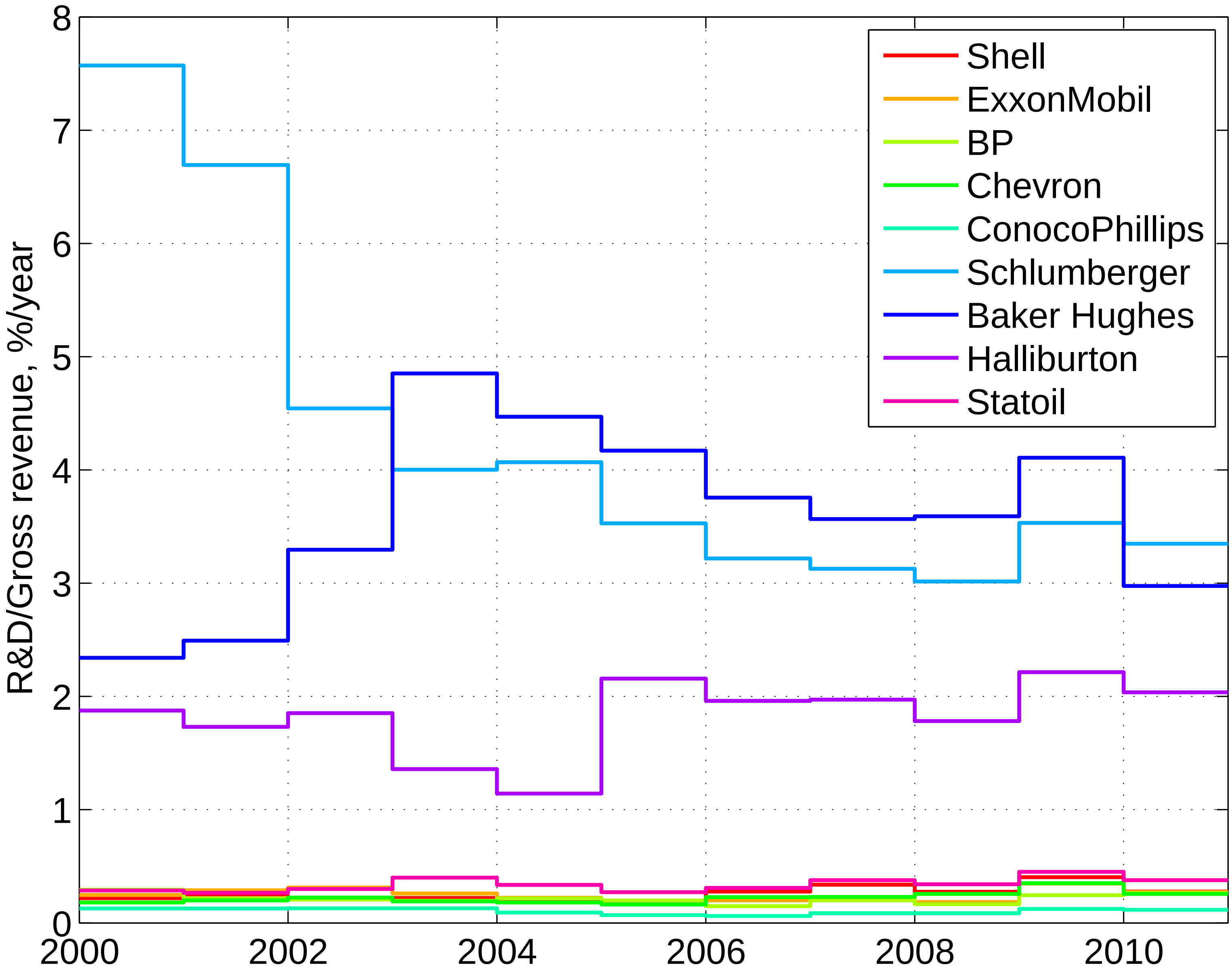


What if Galileo (1610) had the 100-inch Mount Wilson telescope (1918)?

Problem Statement

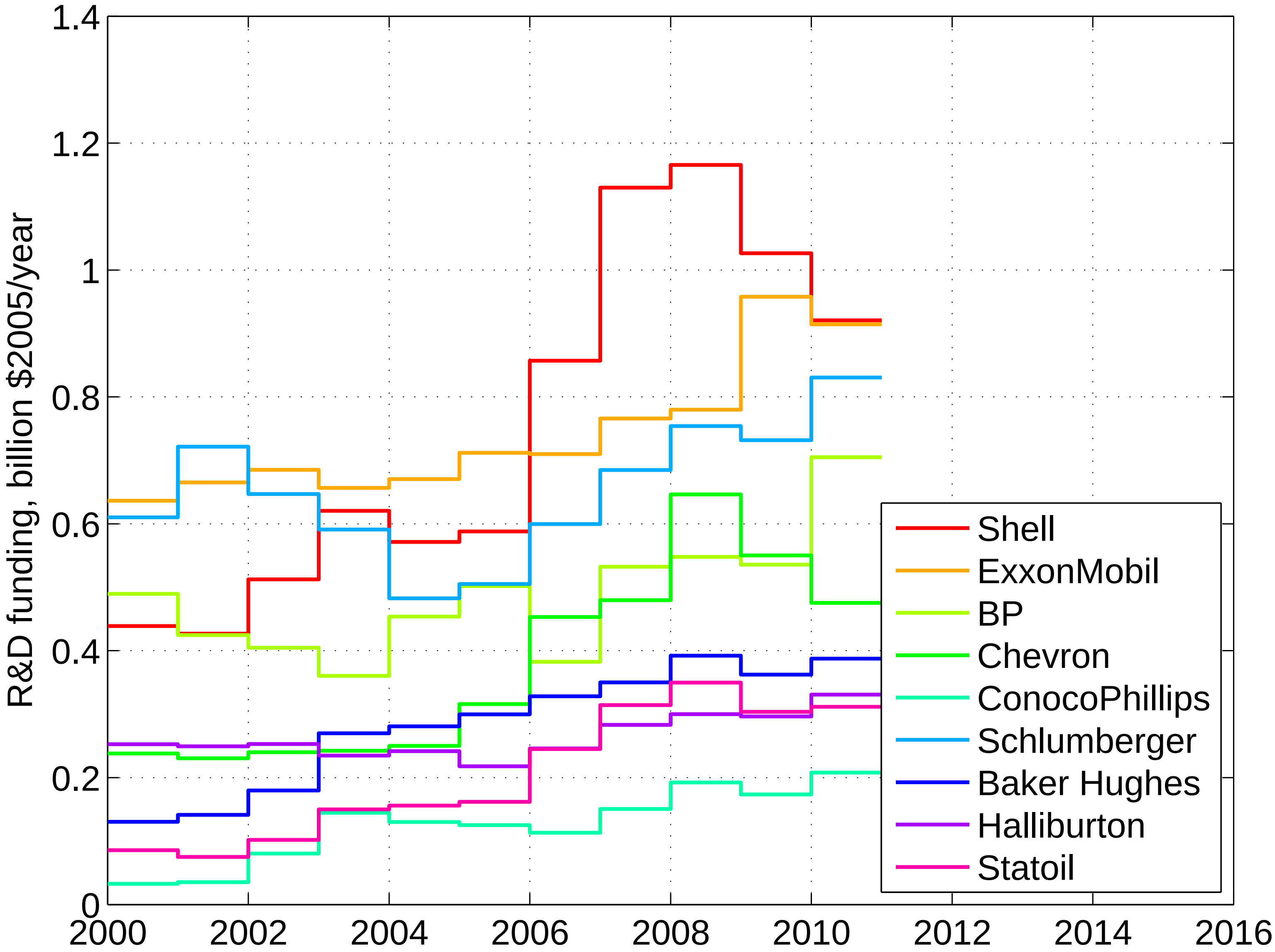
- Drilling and completions are the two highest costs of hydrocarbon recovery
- About 50 percent of drilling and completion costs can be avoided with better technology…
- …But serious research is needed worldwide
- While drilling budgets of the major O&G companies are serious (tens of billions of $ per year), their research efforts are incommensurate with needs

R&D Budget vs. Gross O&G Revenue



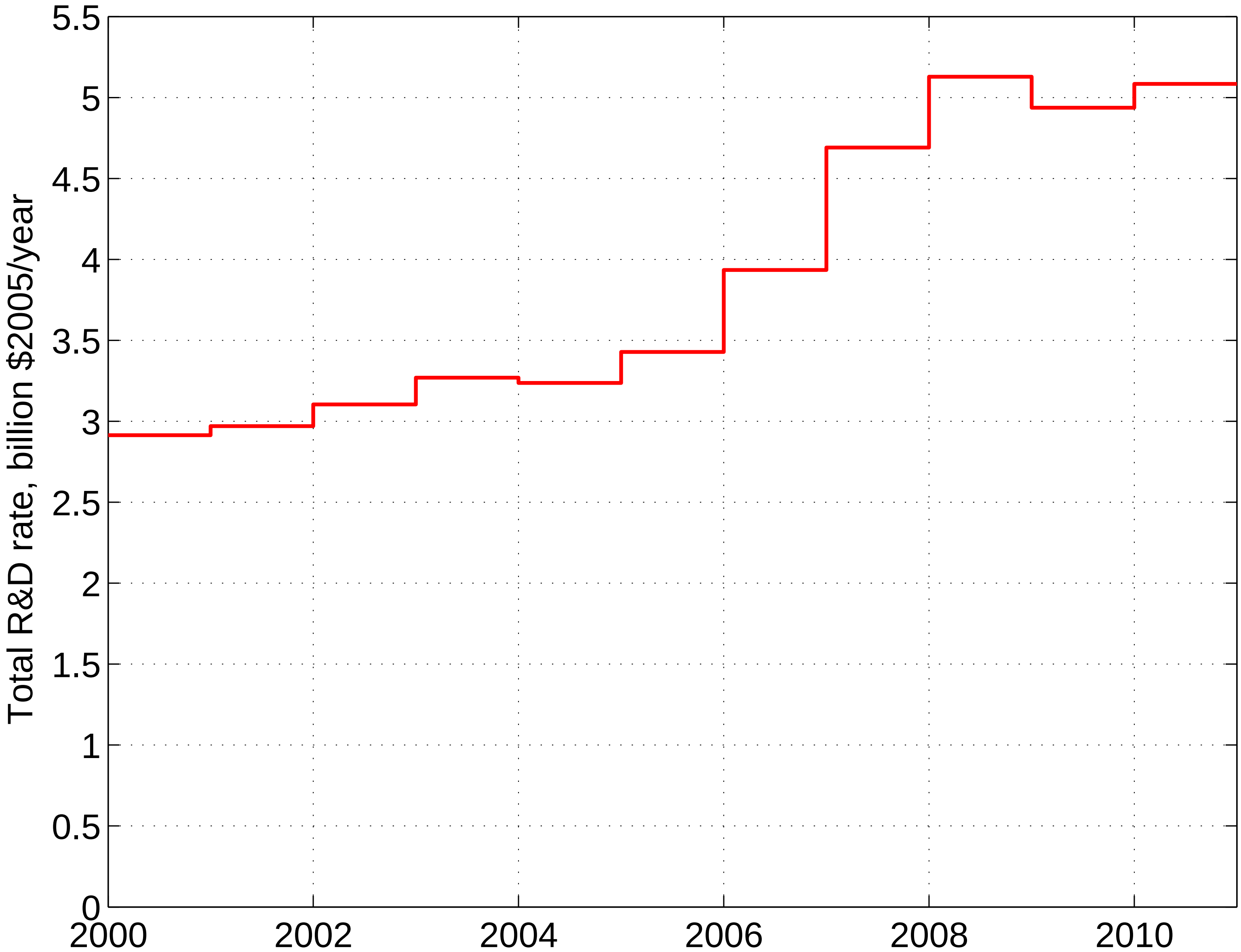
Annual Reports and Financial Statements

R&D Budgets by O&G Company



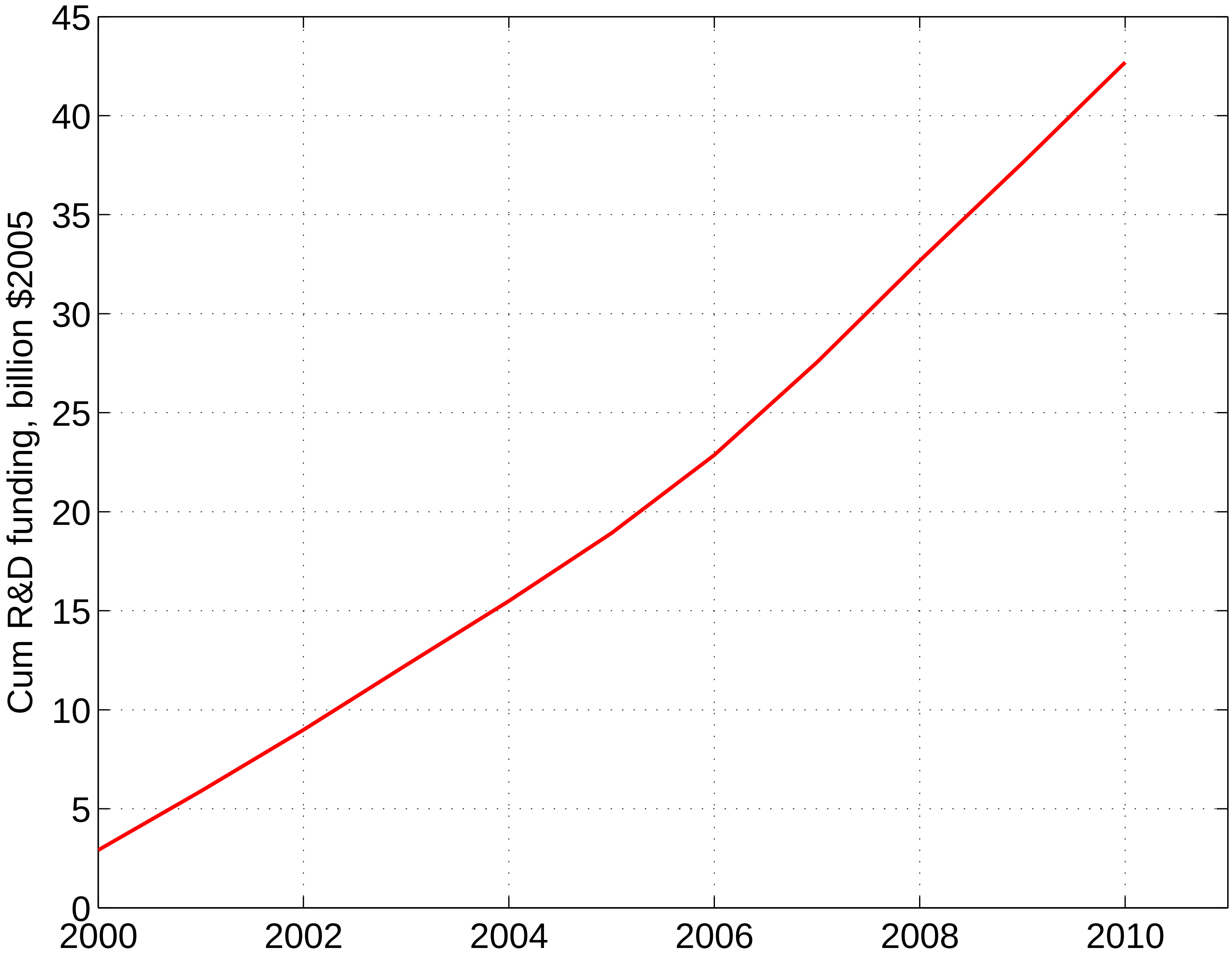
Annual Reports and Financial Statements

Annual R&D Budget in O&G Industry



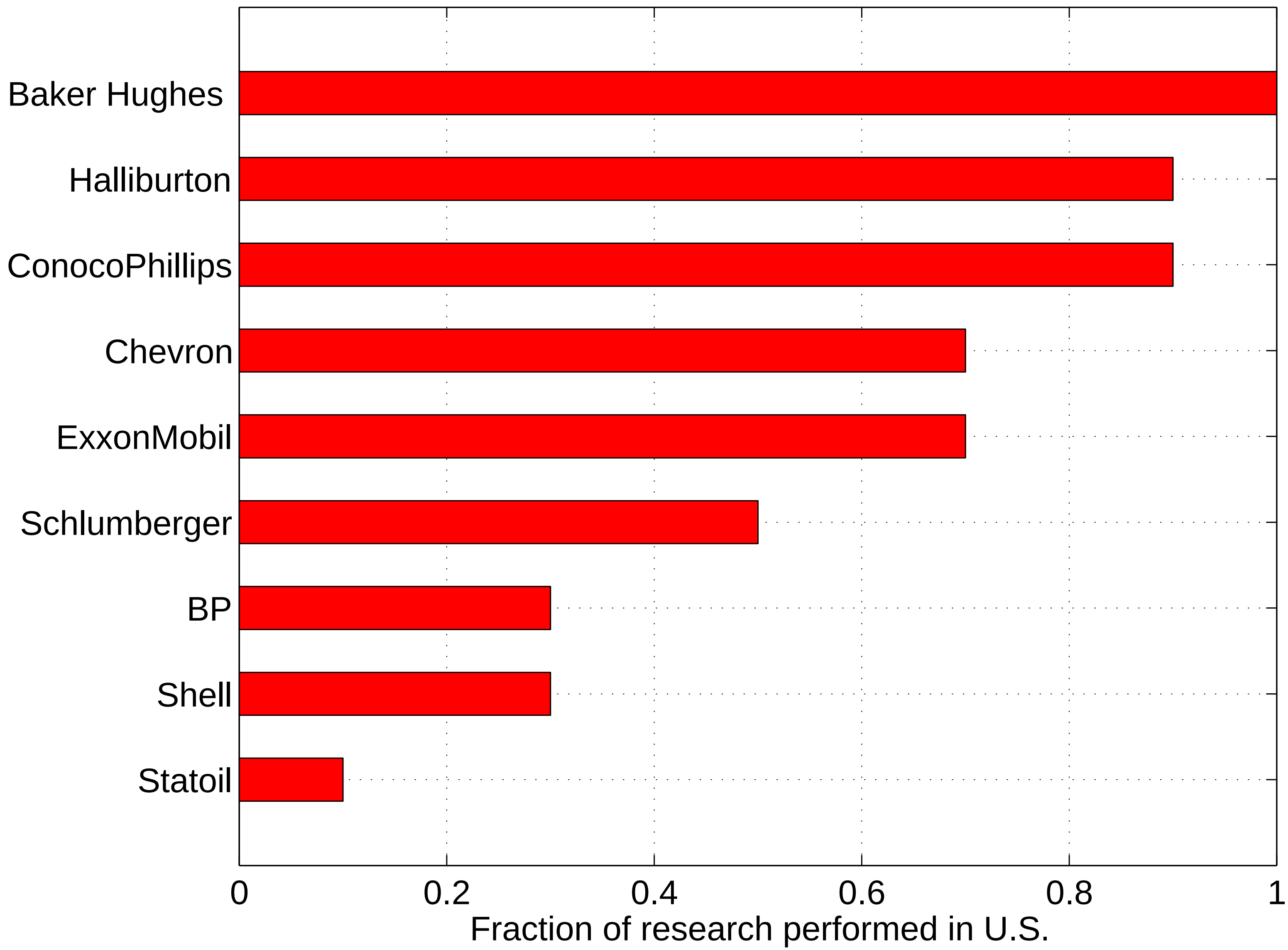
Annual Reports and Financial Statements

Cum R&D Spending in O&G Industry



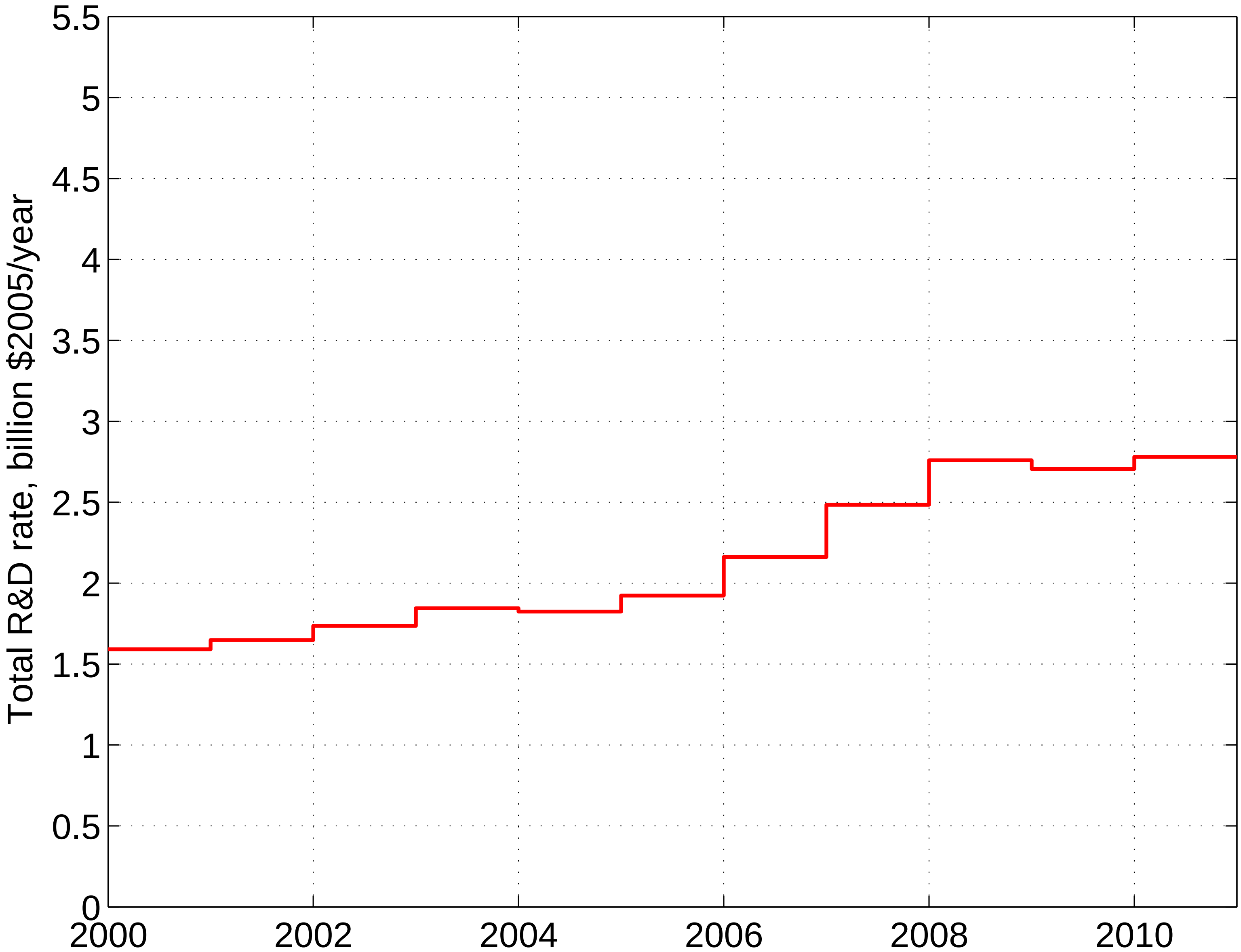
Annual Reports and Financial Statements

O&G R&D Budget Allocation to U.S.



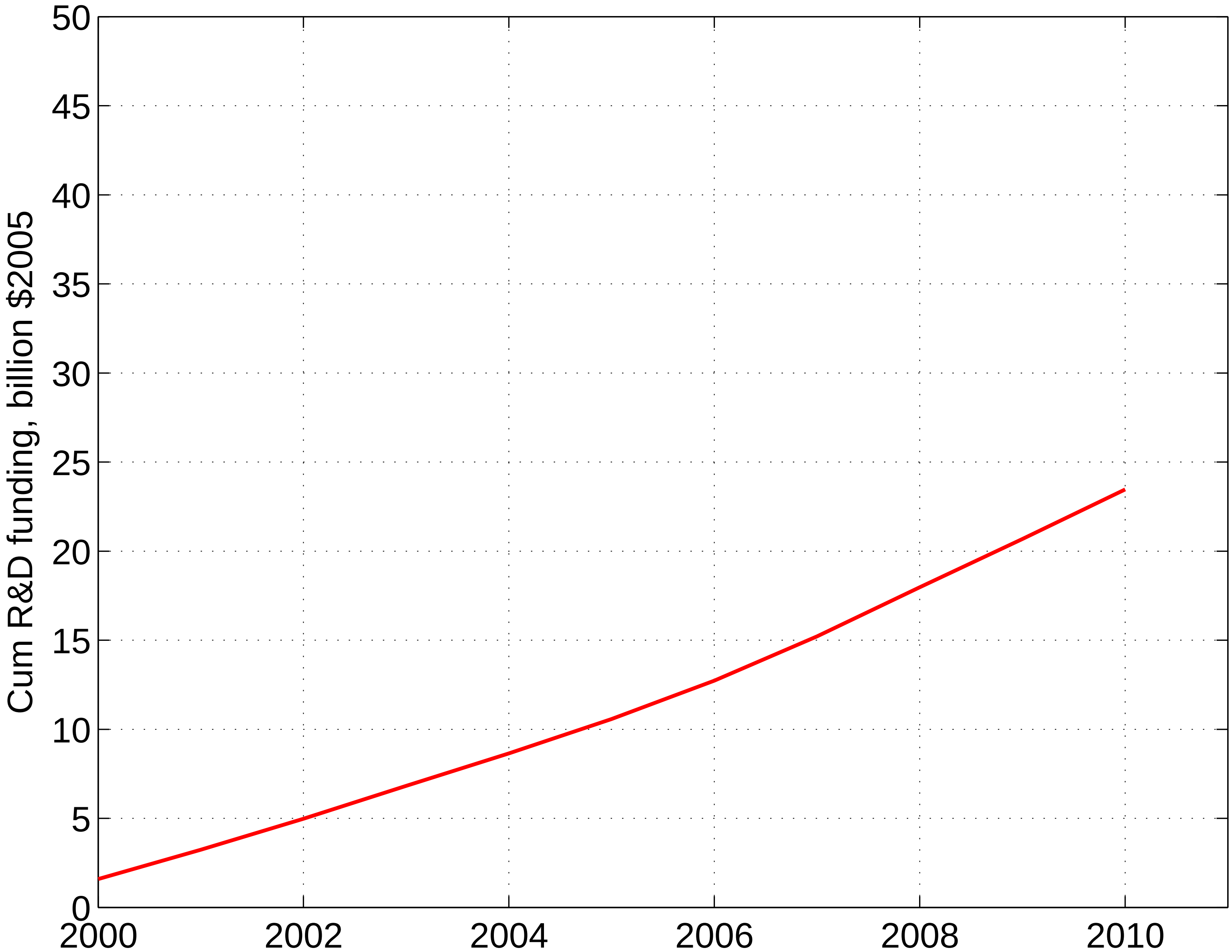
Various estimates

Annual R&D Budget in U.S. O&G



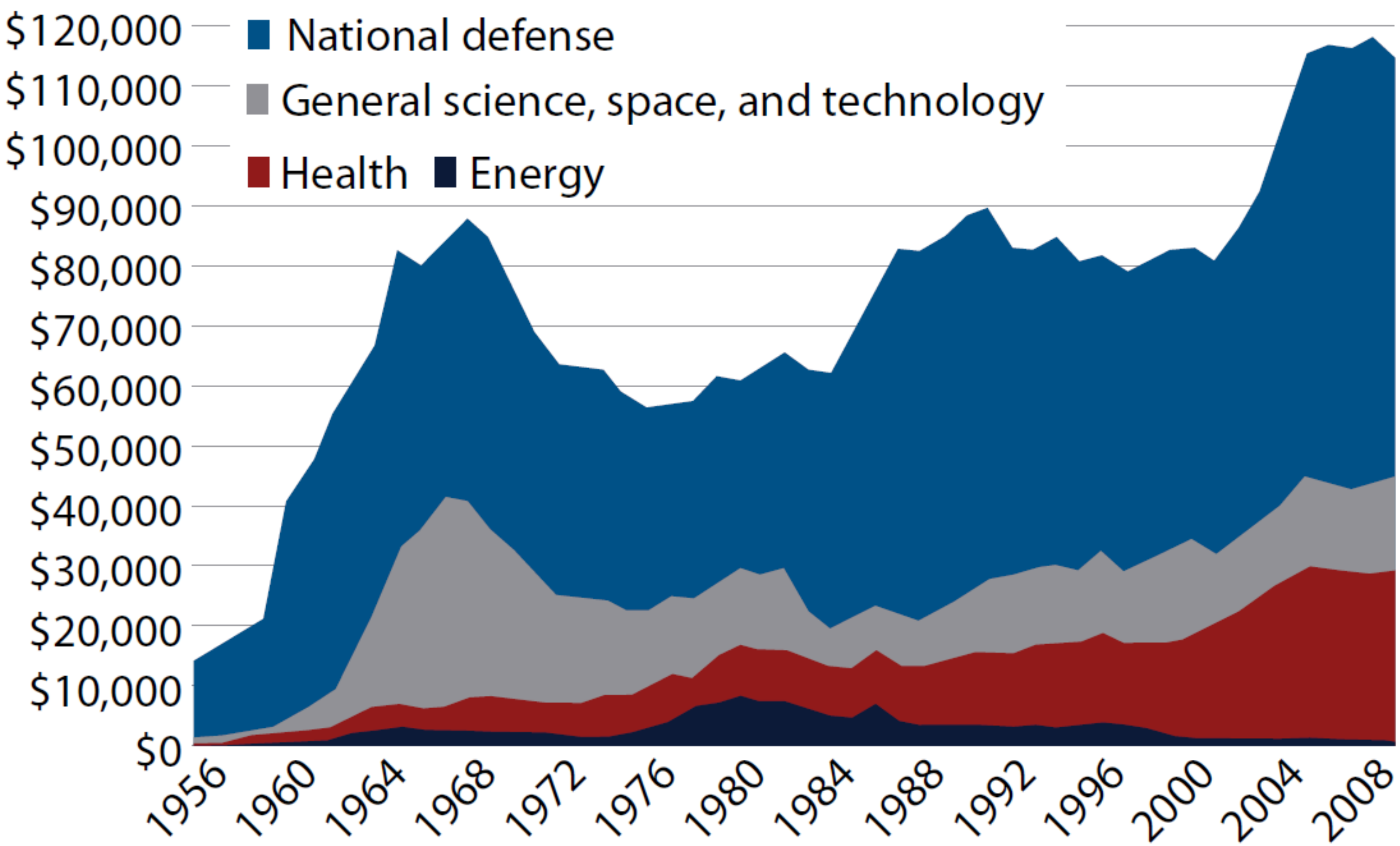
Annual Reports and estimated allocations

Cum R&D Spending in U.S. O&G



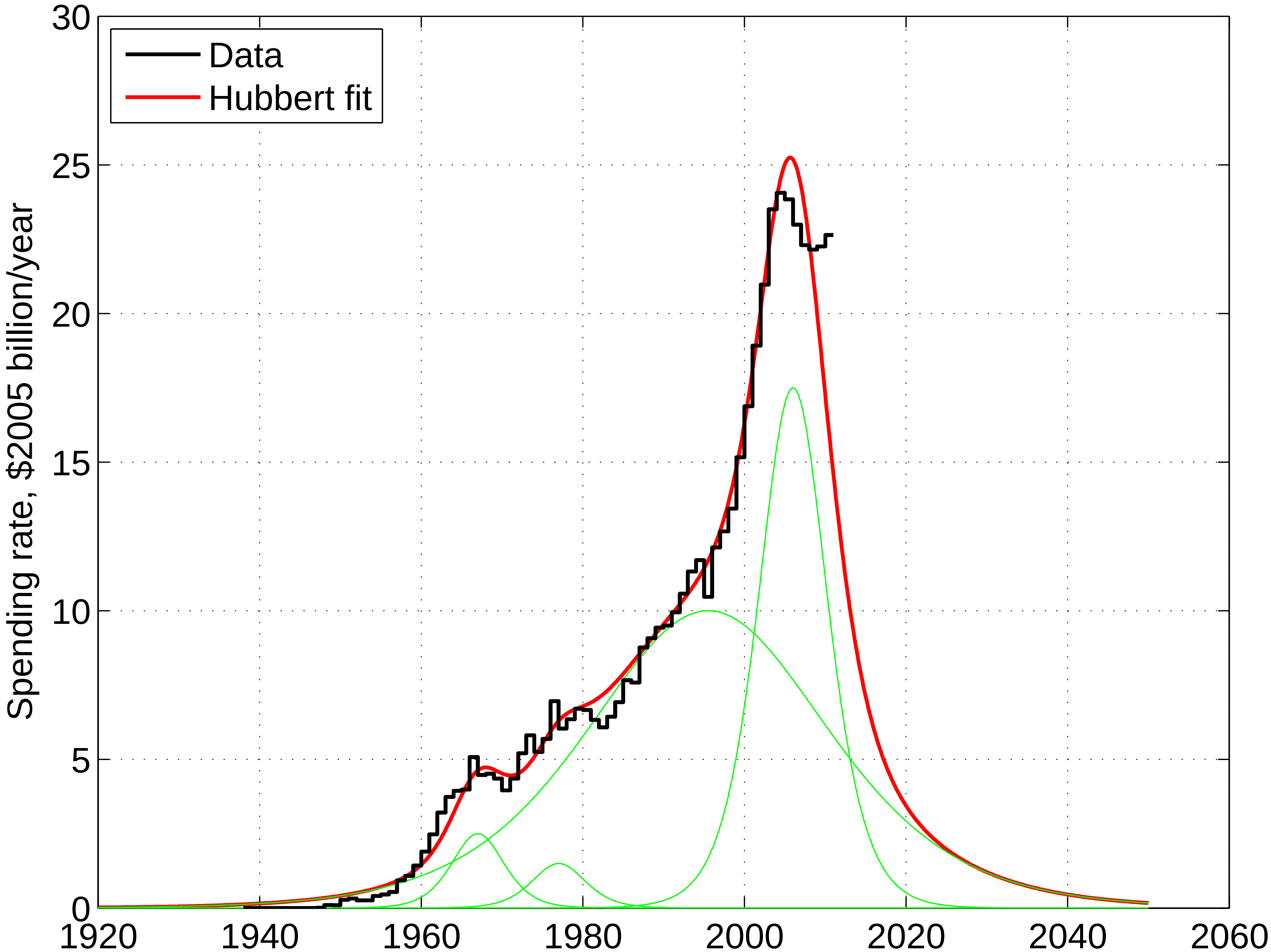
Annual Reports and estimated allocations

Federal R&D Spending



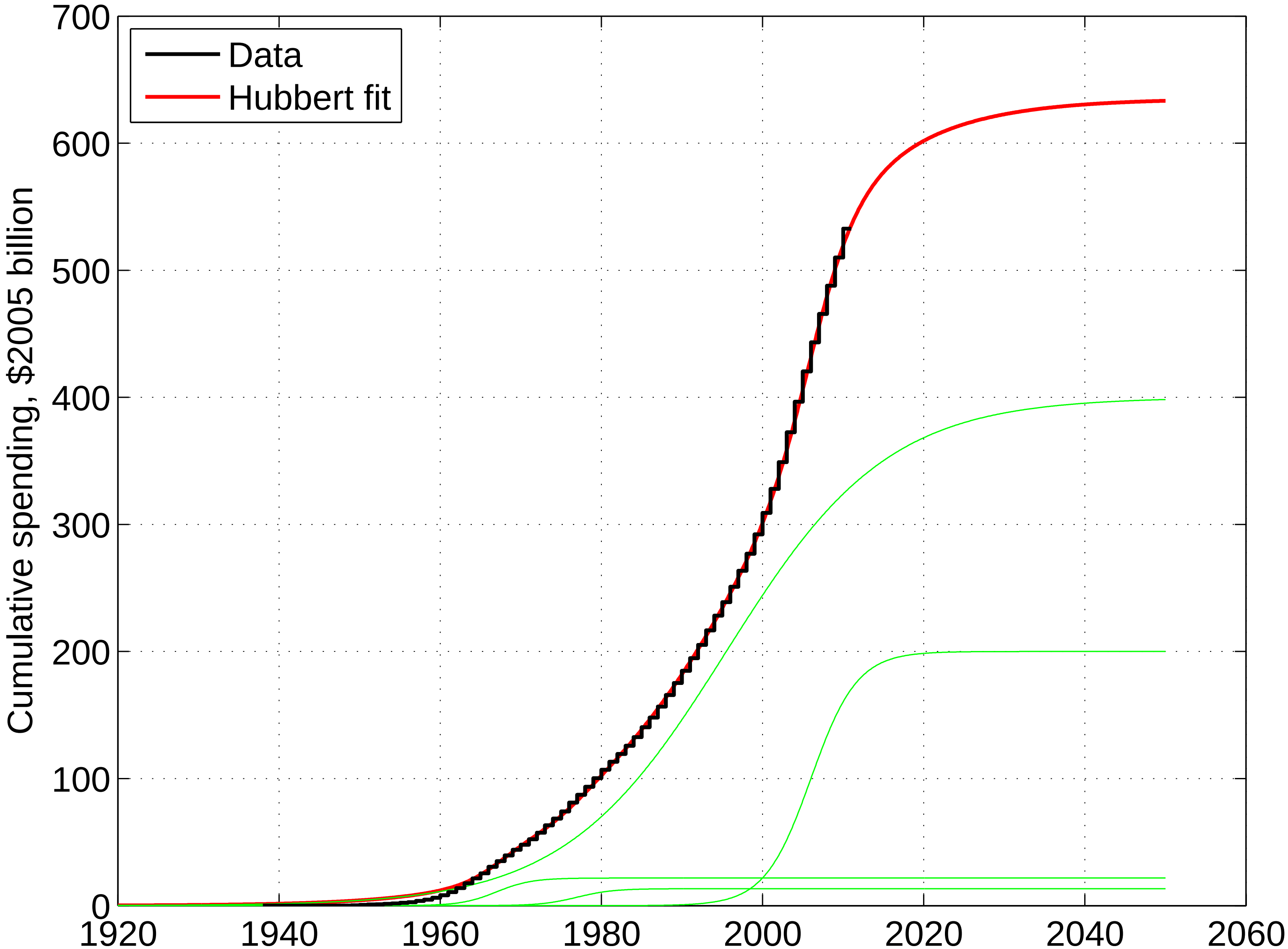
Office of Management and Budget, Fiscal Year 2008 Budget Historical Tables

Annual NIH Spending



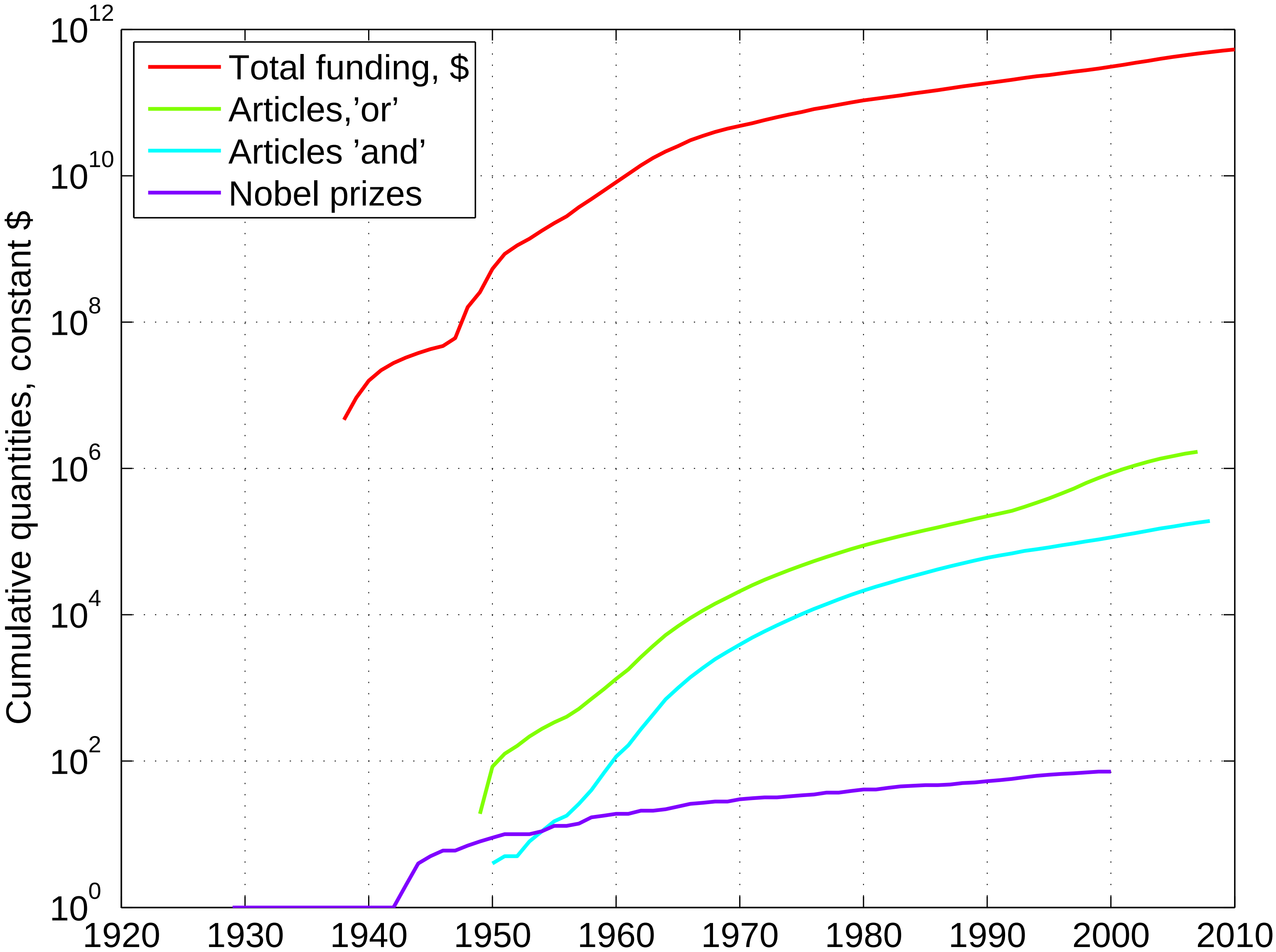
Source: NIH website

Cumulative NIH Spending



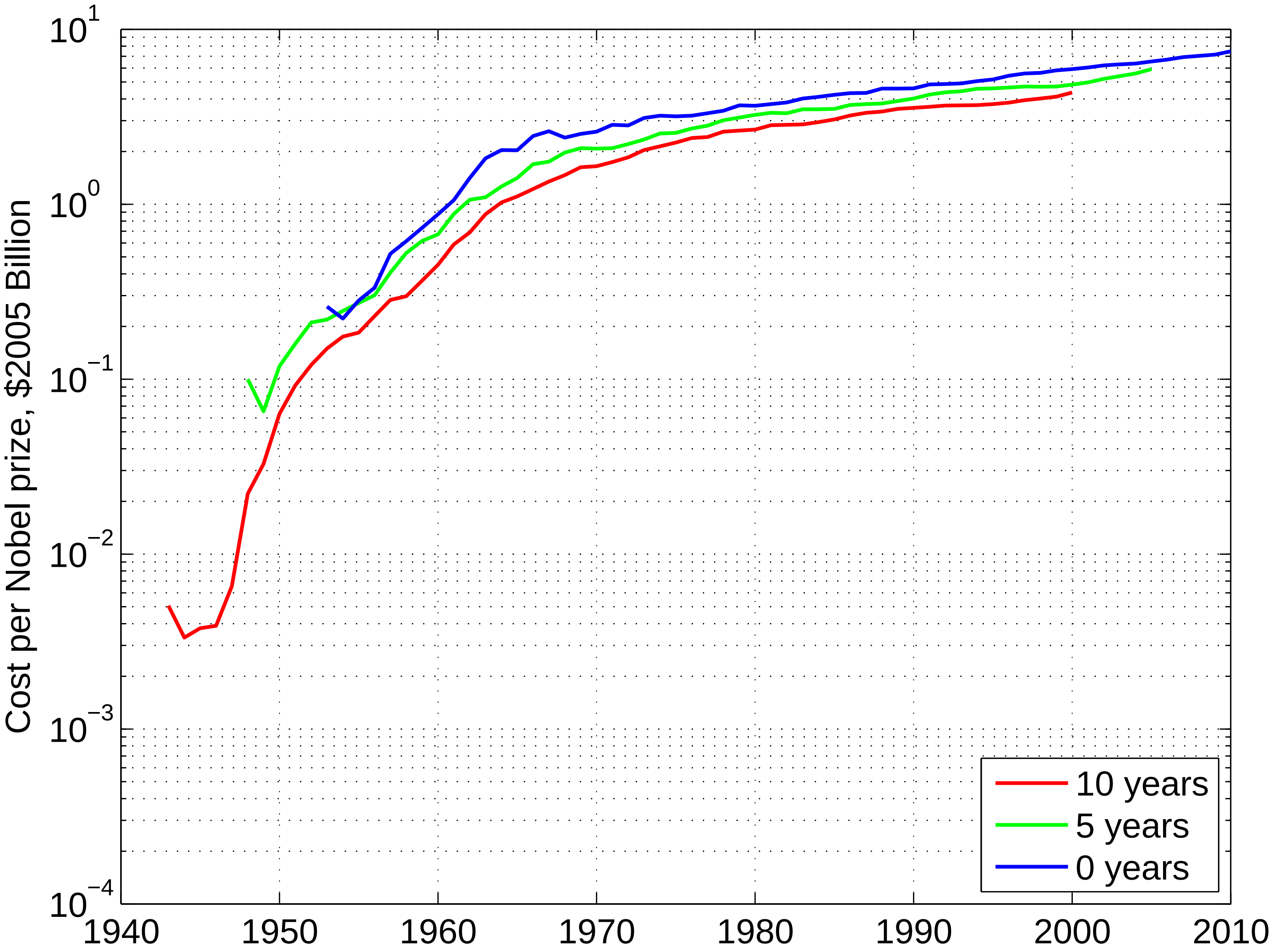
Source: NIH website

Characterization of NIH Spending



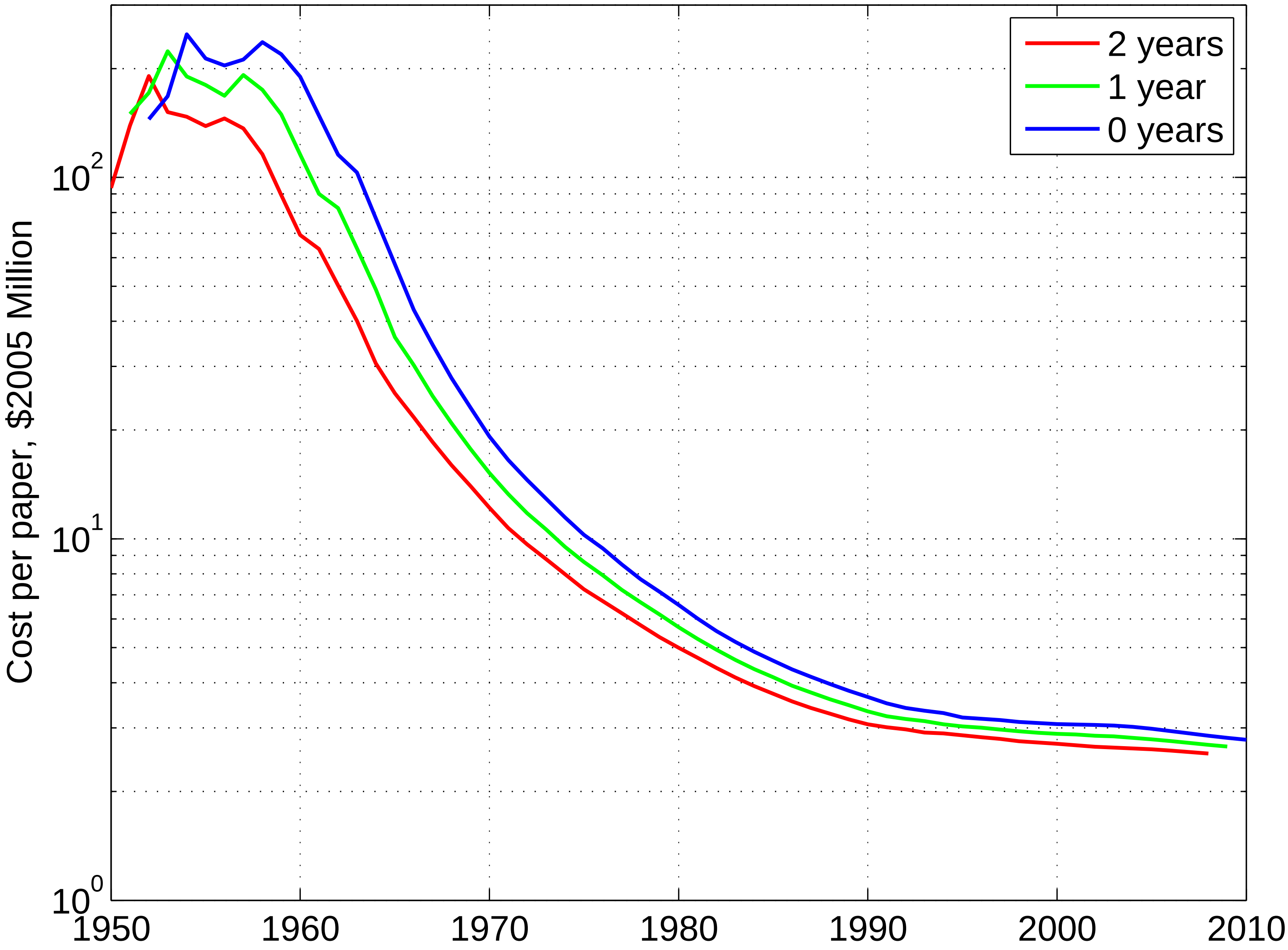
Sources: NIH website, Google Scholar, Nobel Prize website

NIH Spending per Nobel Prize



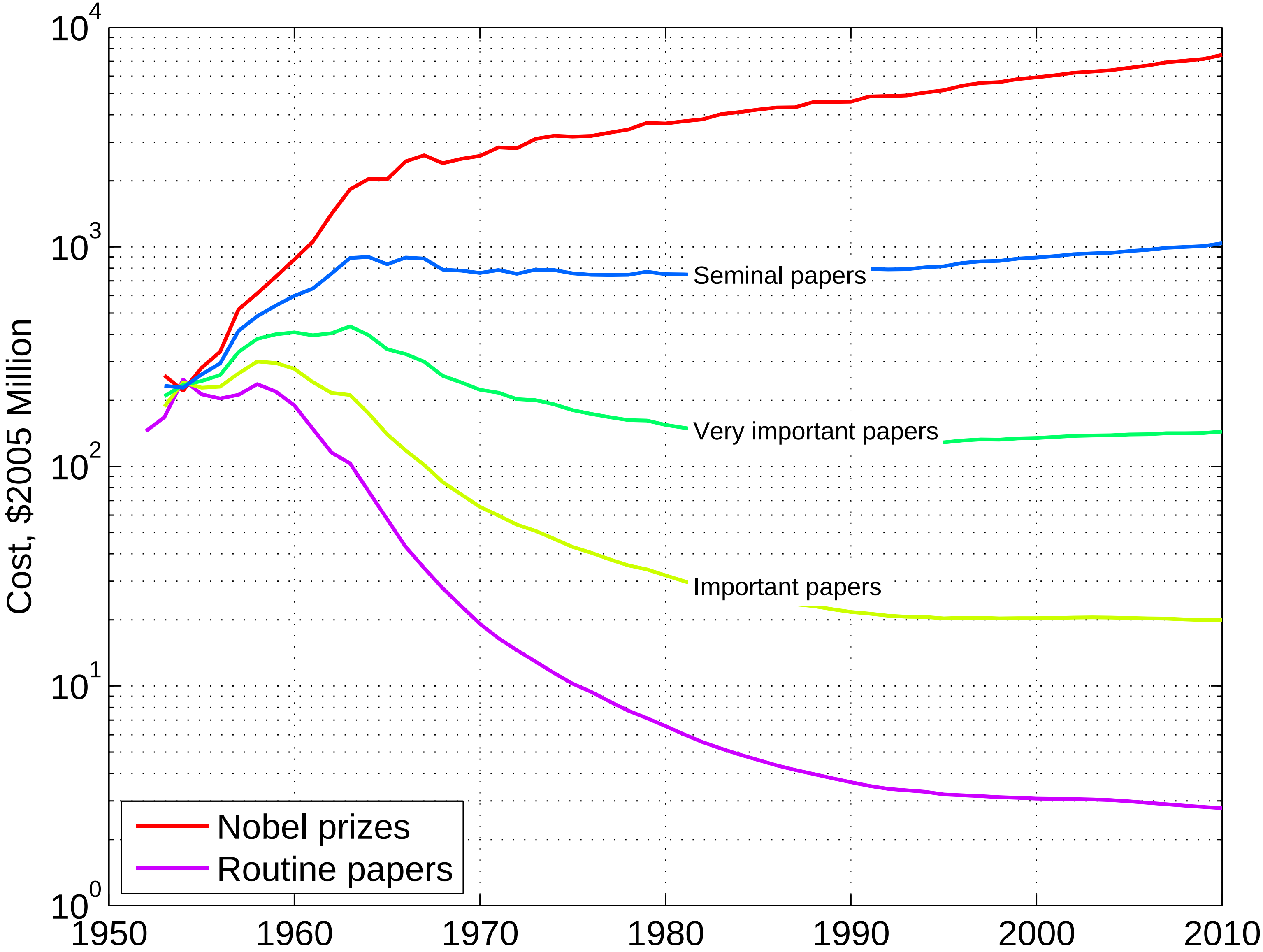
Sources: NIH website and Nobel Prize website

Cost per NIH Paper



Sources: NIH website and Goggle Scholar

Different NIH Papers



Sources: NIH website and Goggle Scholar